MASS. Y3. MPI: T67/2

UMASS/AMHERST

312066 0284 3626 5

Traffic Study
Route 110 Littleton

Phase I - Problem Assessment

August 1984

Metropolitan Area Planning Council

GOVERNMENT DOCUMENTS COLLECTION

Digitized by the Internet Archive
in 2015

https://archive.org/details/trafficstudyrout00mass

Metropolitan Area Planning Council

110 Tremont Street Boston, Massachusetts 02108 (617)-451-2770

Serving 101 Cities & Towns in Metropolitan Boston

ABSTRACT

Title of Report: Traffic Study for Route 110 in Littleton
Phase I: Problem Identification

Funded By: This report was prepared by the Metropolitan Area Planning Council under contracts with the Massachusetts Department of Public Works (FHWA funded contract number MDPW 22946) and the Urban Mass Transportation Administration (contract numbers UMTA-MA-09-0095 and UMTA-MA-09-0107.)

Summary: This report is part of a joint effort with the Northern Middlesex Area Commission (NMAC) to document traffic problems on Route 110 in Littleton, Westford and Chelmsford. Reviewing new development plans and estimating new traffic in the area, a traffic outlook to the year 1990 has been developed. Capacity and safety analysis have indicated that the area of Littleton Common, extending north to I-495 will have severe traffic problems. Other locations in Littleton, including the I-495 interchange at Route 119 and Powers Road will need signalization or other improvements to function properly.

NMAC has prepared the corresponding reports for Westford and Chelmsford.

Author: Carol W. Blair

TABLE OF CONTENTS

	Page
Abstract	i
Table of Contents	ii
List of Tables	iii
List of Figures	iv
Introduction	1
Littleton	
Summary of Findings and Conclusions	1
Areas of Future Analysis	2
Land Use	2
Roadways and Intersections	3
Accident and Safety Analysis	7
Traffic Volumes	7
Base Year Traffic	9
Trips from New Development	9
1990 Traffic	11
Level of Service	15
Capacity Analysis	23
Appendix	29

LIST OF TABLES

		Page
1-L	1975 - 1981 Accidents as Reported by MDPW Records	11
2-L	Comparison of PM Peak Traffic Estimates - Route 110 @ Route 119	26
3-L	Signalized Intersection Levels of Service	29
4-L	Levels of Service for Unsignalized Intersections	30
5-L	Signalized Intersection Analysis for High-Volume Intersections	32
6-L	Level of Service for Minor Streets at Unsignalized Intersections	33

LIST OF FIGURES

		Page
1-L	Littleton Study area	6
2-L	Littleton Common - Proposed Intersection Design	9
3-L	General Office Building Trip Generation Rates	15
4-L	Distribution of Trips to Digital	16
5-L	Distribution of Trips to New Destinations in Westford	18
6-L	Distribution of New Trips west of the Common	19
7-L	1990 Forecast Traffic, Rte. 110 @ I-495, PM Peak Hour	21
8-L	1990 Forecast Traffic, Rte. 110 from Warren St. to Jennifer St., PM Peak Hour	22
9-L	1990 Forecast Traffic, Littleton Common Area, AM Peak Hour	23
10-L	1990 Forecast Traffic, Littleton Common Area, PM Peak Hour	24
11-L	1990 Forecast Traffic, Route 119 @ Powers Road, PM Peak Hour	25

Appendix

A.	Turning Movement Counts - Route 110 @ I-495, Morning Peak Hour (June 6, 1984)	38
B.	Turning Movement Counts - Route 110 @ Warren St. to Jennifer, Morning Peak Hour (June 6, 1984)	39
C.	Turning Movement Counts - Route 110 @ I-495, Evening Peak Hour (June 6, 1984)	40
D.	Turning Movement Counts - Route 110 @ Warren St. to Jennifer, Evening Peak Hour (June 6, 1984)	41
E.	Automatic Traffic Counts - Route 110 between Jennifer St. and Littleton Common, (June 6-8, 1984)	42
F.	Automatic Traffic Counts - Route 110 between Jennifer St. and Littleton Common, (June 20-22, 1984)	43
G.	Automatic Traffic Counts - Route 110 between I-495 NB exit and Warren St. (June 20-22, 1984)	44
H.	Turning Movement Counts - Littleton Common, AM Peak Hour (August 18, 1983)	45
I.	Turning Movement Counts - Littleton Common, PM Peak Hour (August 18, 1983)	46
J.	Turning Movement Counts - Littleton Common, AM Peak Hour, 1980	47
K	Turning Movement Counts - Littleton Common, PM Peak Hour, 1980	48
L.	1984 AM Peak Hour Traffic at Littleton Common	49
M.	1984 PM Peak Hour Traffic at Littleton Common	50
N.	Turning Movement Counts - Route 119 @ Powers Road, AM Peak Hour, (Devember 1, 1983)	51
O.	Turning Movement Counts - Route 119 @ Powers Road, PM Peak Hour, (December 1, 1983)	52

INTRODUCTION

This report is part of a joint effort with the Northern Middlesex Area Commission (NMAC) to document traffic problems on Route 110 in Littleton, Westford, and Chelmsford. Since Littleton is within MAPC's region, MAPC has worked with NMAC in this study and performed the work which relates specifically to Littleton. Anticipating a large amount of development, these towns requested a study to review development plans near Route 110 and to project traffic impacts. This report offers a traffic outlook to the year 1990 and identifies foreseeable traffic problems.

Summary of Findings and Conclusions for Route 110 Area of Littleton

The following sections present current traffic levels and projections to 1990 for the Littleton portion of the Route 110 study. Based on these traffic levels and physical characteristics of the area's road network, a detailed analysis of present and future traffic operating conditions is presented. The following points are drawn from this analysis.

- by 1990, new development by Digital at Littleton Common and new development in Westford will cause a large amount of traffic growth. In the evening (p.m.) peak hour, Digital is expected to generate nearly 900 vehicle trips and Westford developments are expected to generate over 700 new trips through Littleton; a growth of at least 1600 auto trips passing through the Common and other streets in the area between 5 and 6 p.m.

- By 1990, traffic on Route 110 in Littleton will have increased dramatically from 1984 levels. On Route 110 at the western limit of the study area, I-495, evening peak hour traffic will have increased by about 50 percent (267 vehicles per hour.) On Route 110 at the eastern limit, traffic will grow by 160 percent in the evening peak hour (707 vehicles per hour).

- Traffic at Littleton Common is expected to exceed the projections which are the basis for currently proposed improvements to the intersection of Routes 110 and 119. As a result it is expected that traffic flows during the 1990 evening peak hour will exceed the intersection's new capacity by 55 percent.

- Points of access and egress for Digital, designed without signal control, will not be adequate to serve 1990 Digital traffic and through traffic.

- There will be such high growth in traffic using I-495 to reach Digital and other destinations via Route 119 and the Common that the I-495/Route 119 interchange will fail in the morning and evening peak hours. In the morning the heavy movement will be vehicles travelling northbound on I-495 and exiting with a left turn to Route 119 southbound (36 percent over capacity.) In the evening, the problem will be vehicles travelling north on Route 119 and turning left into I-495 southbound (89 percent over capacity.)

o Peak hour flow at Powers Road is already poor in 1984. With no signal control and almost 500 vehicles per hour attracted to new development in 1990, this intersection will fail during the evening peak hour.

o Of the remaining intersections in the study area, the following will not operate effectively in 1990 under existing traffic control:

Route 110 @ I-495 SB and Murray Park Road
Route 110 @ I-495 NB
Route 110 @ Goldsmith, Stevens Streets
Route 110 @ Jennifer Street

Areas of Future Analysis

As stated in the introduction to this report, Phase 1 of this study is problem identification. Having documented foreseeable traffic problems, it is appropriate to consider the agenda for Phase II.

Of the problem locations identified above, some may be improved to operate satisfactorily through signal control. But there is an area of this network which is much more challenging: Route 119 from Route 110 to I-495. It is expected that failure will occur during at least one of the peak hours at almost every point of conflict on this section even if all movements are under signal control and intersection improvements at Routes 110/119 are built.

Phase II of this study should take a broad view of this problem, considering

o possible diversion of traffic due to severe congestion

o additional development which could make the problem still more severe, and means to accommodate or control such growth.

o innovative measures such as remote parking, ridesharing, staggered work hours, and

o probably most practical, redesign of the intersections to increase capacity

The town of Littleton must play a major role in Phase II.

LAND USE

Land adjacent to Route 110 in Littleton is zoned residential west of White Street. Properties abutting Route 110 are zoned for business east of White Street to the Westford Town Line. Along Route 119, between I-495 and the business properties on Route 110, zoning is for industrial uses.

With the exception of the proposed Digital facility at the Common, no large developments are planned within the study area. The area near

I-495 and Route 2 seems to be the focus of large development proposals in Littleton (Approximately 260 acres available.) There are no current housing proposals for more than 20 units each. There have been two recent proposals for the area north of I-495 near Rte 119. One parcel, on Russell Street has been rezoned residential. Another, owned by GenRad, is on hold. Digital's plan, however is to construct 495,000 sq. ft. of office space at Littleton Common (now in progress). This site is immediately adjacent to Routes I-495, 110, 2A and 119, as well as the many small businesses in the Common area.

ROADWAYS AND INTERSECTIONS

Road and street system characteristics are documented here to establish a basis for evaluation of the capacity and safety of the system, Route 110 is the focus of this study, however intersecting streets are included.* Figure 1-L shows the study area.

Route 110 is a two-lane highway classified by the state as a rural minor arterial over most of the length under study. Pavement is 22 feet wide and shoulders are 4 feet on each side. Near I-495, pavement widens to 24 feet and shoulders to 10 feet.

The highway intersects 14 other streets and roads along the section studied. Only one of these intersections (Route 119) is signalized. Between Shattuck St. and the Meetinghouse Road the intersections are closely spaced.

The I-495 interchange at Route 110 is the western limit of this study. I-495 is part of the Interstate Highway System and provides an outer circumferential route around Boston. The interchange has ramps in the southwest and southeast quadrants which accommodate all entering and exiting movements. Built to Interstate highway standards, the ramps meeting Route 110 are 20 feet wide with large curb returns.

Murray Park Road meets Route 110 just west of this interchange and acts as part of the intersection of Route 110 with the southbound (SB) ramps. Murray Park Road has 30 feet of pavement and a 3-foot shoulder.

Warren Street is a local road with 23 feet of pavement and 2 foot shoulders. It forms a T intersection, approaching Route 110 from the south.

Russell Street forms another T intersection, approaching from Route 119 to the north. Russell Street is a local road with 23 feet of pavement and 2-foot shoulders and provides access to the high school.

*Powers Road is not within the Route 110 corridor but is within the area of influence of developments considered in this study. The Town of Littleton has asked that the intersection of Route 119 with Powers Road be included.

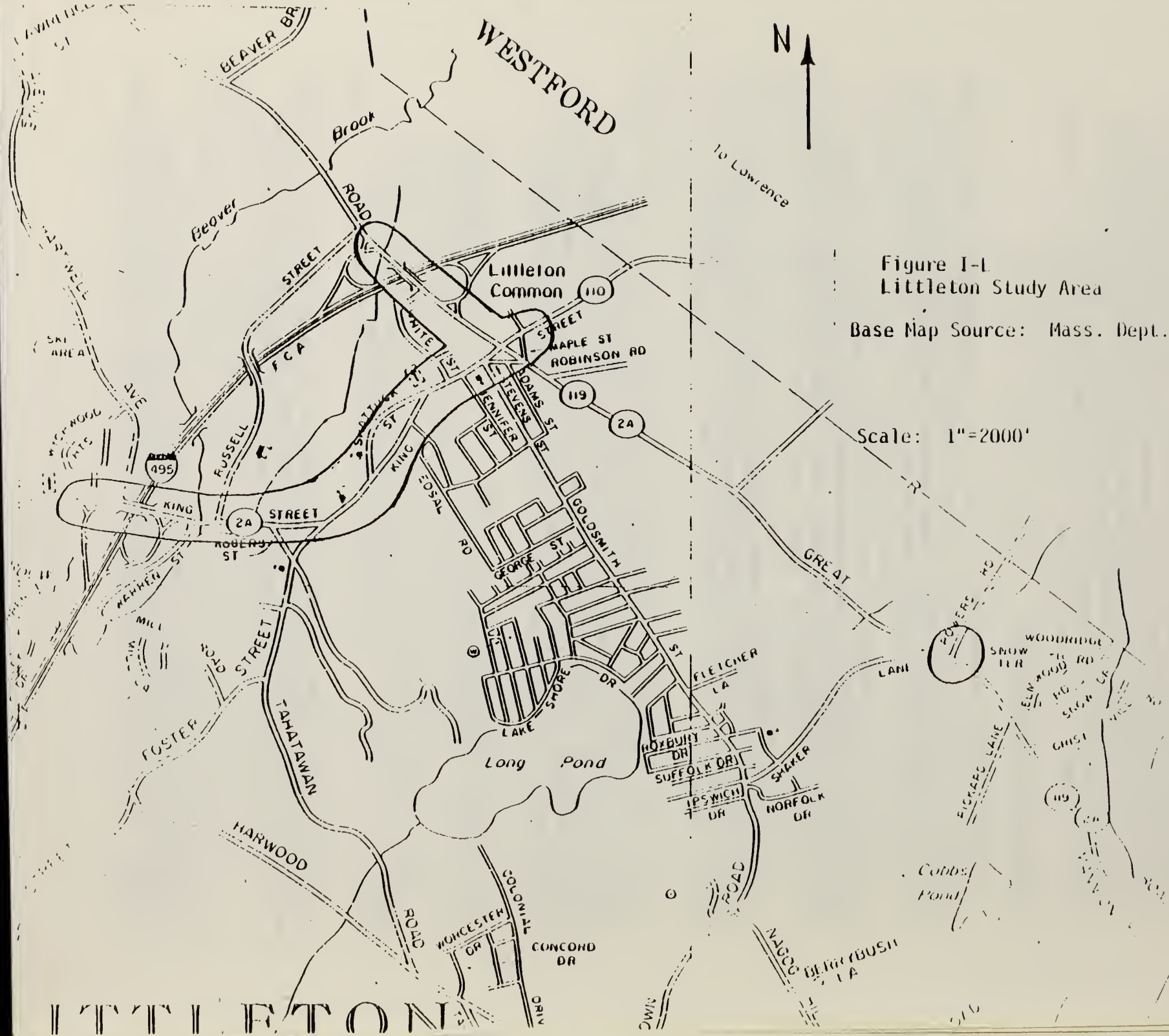


Figure I-1
Littleton Study Area

Base Map Source: Mass. Dept. of Public Works

Scale: 1"=2000'

Foster Street and Rogers Street approach from the south and cross just before meeting Route 110, forming an intersection area with triangular flow. These streets are classified as rural minor collectors. Rogers Street has 38 feet of pavement with 2-foot shoulders. Foster Street has 24 feet of pavement with 2-foot shoulders. Control at the Foster Street entrance to Route 110 is a yield sign rather than a stop sign. The stop sign at Rogers Street is supplemented by a flashing beacon.

Shattuck Street is not significant from a traffic perspective. It is 0.3 miles long, beginning and ending at Route 110 and meeting no other streets. The street provides access to a school building used currently for administration.

Baldwin Hill Road forms a T intersection with Route 110, approaching from the southeast. Baldwin Hill Road, classified as local, has 31 feet of pavement and 2-foot shoulders.

White Street is a short L connecting Route 110 just west of the Common with Route 119 just North of the Common. The street is 0.3 miles long, has 20 feet of pavement and 2-foot shoulders.

Jennifer Street approaches Route 110 from the southeast to form another T intersection. This street has 22 feet of pavement and 2-foot shoulders.

Goldsmith Street is a major collector street for residential streets to the south, near Long Pond. Goldsmith St. has 28 to 30 feet of pavement and 2-foot shoulders.

Route 119 (Great Road), classified as a rural minor arterial, runs through Littleton, from Acton to Groton. Route 119 has 24 feet of pavement and 3 foot shoulders. On the north side of Littleton Common, Route 119 and Route 110 cross at a signalized intersection. Traffic flow is complicated by two triangle shortcuts around the Common (Meetinghouse Road and Stevens Street.) Stevens Street has 37 feet of pavement with a 2-foot shoulder on the Common side and sidewalk on the other. Meetinghouse road has 24 feet of pavement with 2-foot shoulders.

This intersection will soon be improved to ease traffic flow. Design plans show two lanes on each approach, with exclusive left lanes designated for Route 119. Stevens Street and Meetinghouse Road will become one-way eastbound and an extra lane will be provided between Digital and I-495 northbound ramps for traffic moving directly from Digital to I-495 NB. A sketch of the proposed design is included as figure 2-L.

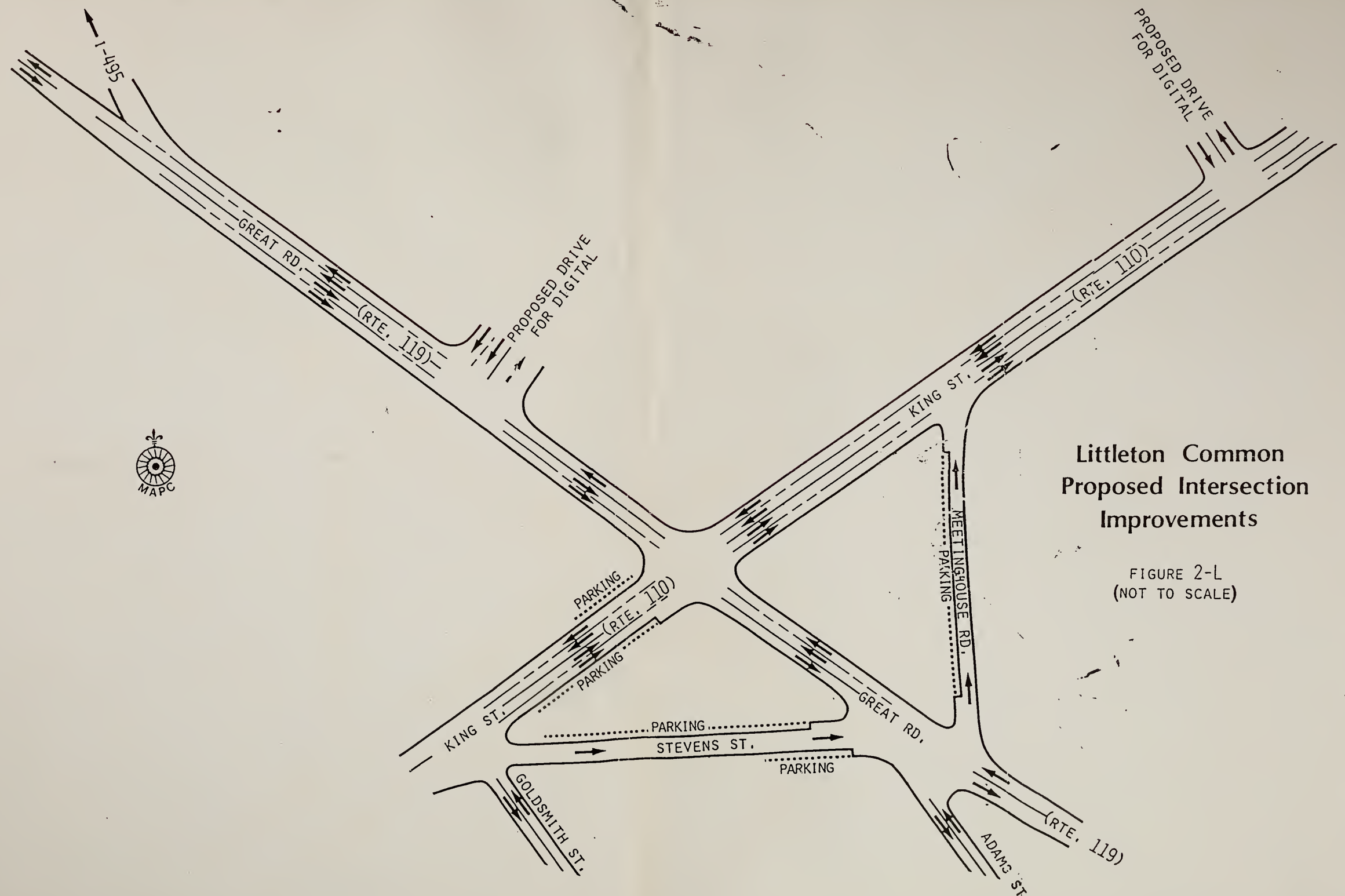
Powers Road meets Route 119 about 1.5 miles south of Route 110. Approaching from Westford, to the east, Powers Road is classified as a rural minor collector. The roadway is 20 feet wide with 2-foot shoulders and is channelized at this intersection.

Table 1-L

1975-1981 Accidents as Reported by MDPW Records

Location	Angle/cross Movement	Vehicle Backing	Parked Vehicle	Crossed ℄	Rear-end	Head-on	Hit-fixed object or ran off road	Under Signal Control	No Traffic Control	Snow	Total
Common Area	*39	14	7	2	8	4	3	22	29		59
Rogers					1						
Foster (Yield)	1			1	2				1		4
Warren					2		1		2	2	3
Russell					2	1				3	3
Shattuck	1					1	1		2	1	
I-495	1		2				2			3	5

*Route 110 @ Route 119, Stevens, Goldsmith, Meetinghouse, Littleton Sub Shop, Donelan's Lot



Littleton Common
Proposed Intersection
Improvements

FIGURE 2-L
(NOT TO SCALE)

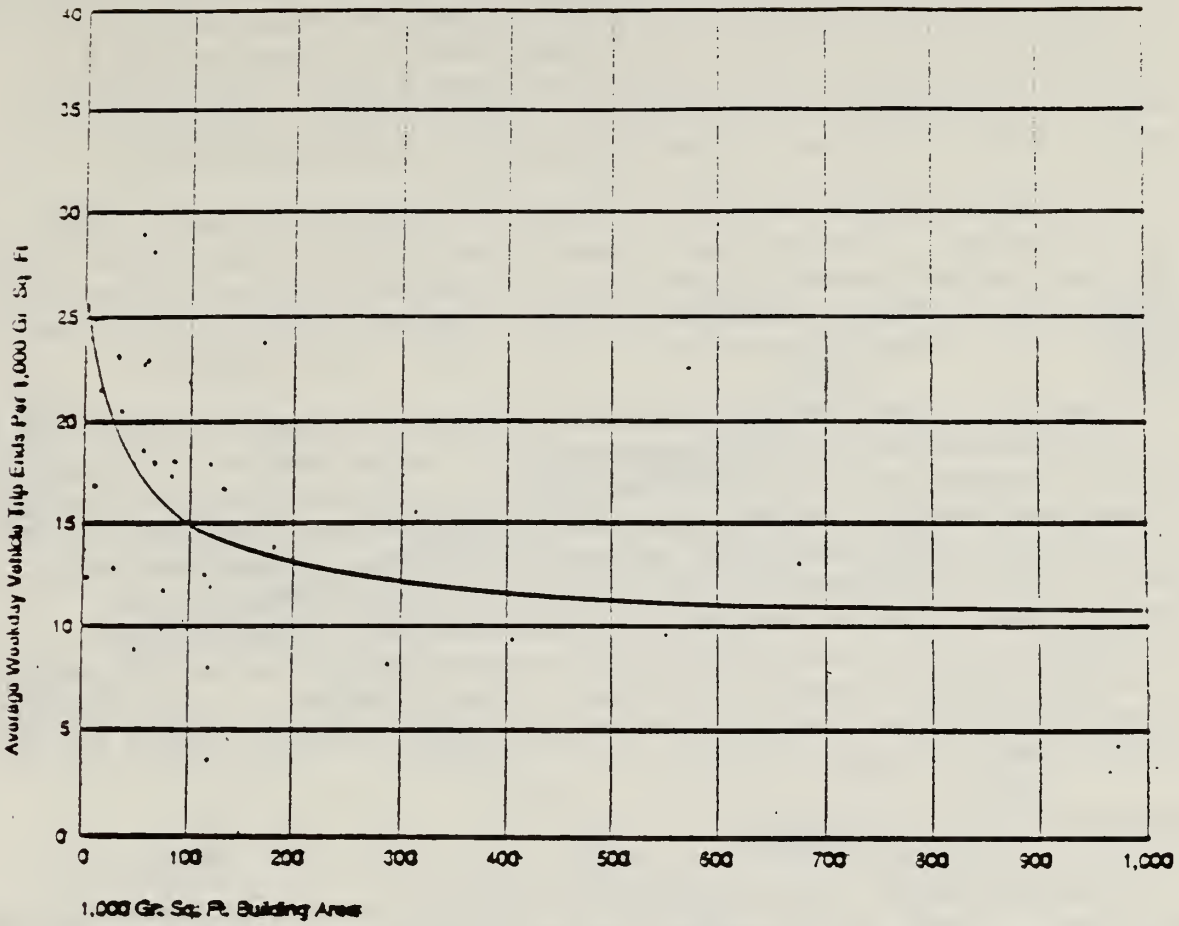


Figure 3-L
General Office Building Trip Generation rates

Source: Institute of Transportation Engineers
Trip Generation. Third Edition
(1982)

Base Year Traffic (1984)

Base year traffic (1984) has been determined from field observations of peak period turning movements made by MAPC and the town, automatic traffic recorders provided by NMAC, and data from other studies.

Turning movements were counted from 7 to 9 a.m. and from 4 to 6 p.m. on June 6, 1984. Peak hours of traffic were determined to be 7:45 to 8:45 a.m. and 5:00 to 6:00 p.m., the evening peak hour experiencing considerably heavier traffic than the morning peak. Results of this survey are included in the appendix. Truck traffic represented approximately 2 percent of the traffic flow during these hours.

Automatic traffic counters were used to measure 24 hour traffic levels and variations. Counters were placed across both travel lanes of Route 110, one between Warren Street and access ramps to Route 495 and another between Jennifer and Goldsmith Streets, counting traffic for at least 24 hours on two separate occasions in June, 1984. (See appendix)

Traffic volumes for the area near Littleton Common and Route 119 at I-495 were estimated from data included in recent studies to evaluate the traffic impacts of the Digital facility* at the Common and of Westford Technology Park**. Traffic analysis for Digital was performed in 1981 using 1980 traffic counts for the area around the Common, including the Route 119/I-495 interchange, as well as Goldsmith, Stevens, and Meetinghouse. Traffic analysis for the Westford Technology Park is based on 1983 counts for the simple 4-way intersection of Routes 110 and 119 (did not include Goldsmith, Stevens, or Meetinghouse.) These data (see appendix) were used together, to estimate 1983 traffic volumes for the larger area surveyed in 1980.

Trips from New Developments

Trip generation from Digital is expected to be higher than originally estimated. In the environmental impact report prepared for Digital, it was assumed that trip generation would be at the rate of 8.36 trips per thousand square feet of floor area per day. (This rate was taken from another study for a proposed GenRad facility nearby). Figure 3-L indicates a rate of 11.9 would be more appropriate. Local observations indicate similar trip generation activity, including a rate of approximately 12.3 for a Digital plant in Nashua, N.H.***

* Symmes, Maini & Mckee, Draft and Final Environmental Impact Reports for Digital Equipment Corporation, Littleton Common Project EOEA #03950 (August, 1981)

** Vanasse/Hangen Assoc., Draft and Final Environmental Impact Reports for Westford Technology Park, EOEA #4676 (September, 1983).

*** Vanasse/Hangen Assoc., Conon Forge Realty Corp Traffic Impact Study December '83,) p. 38.

The distribution of trips shown here was developed in the environmental impact review performed for the Digital proposal in 1981.

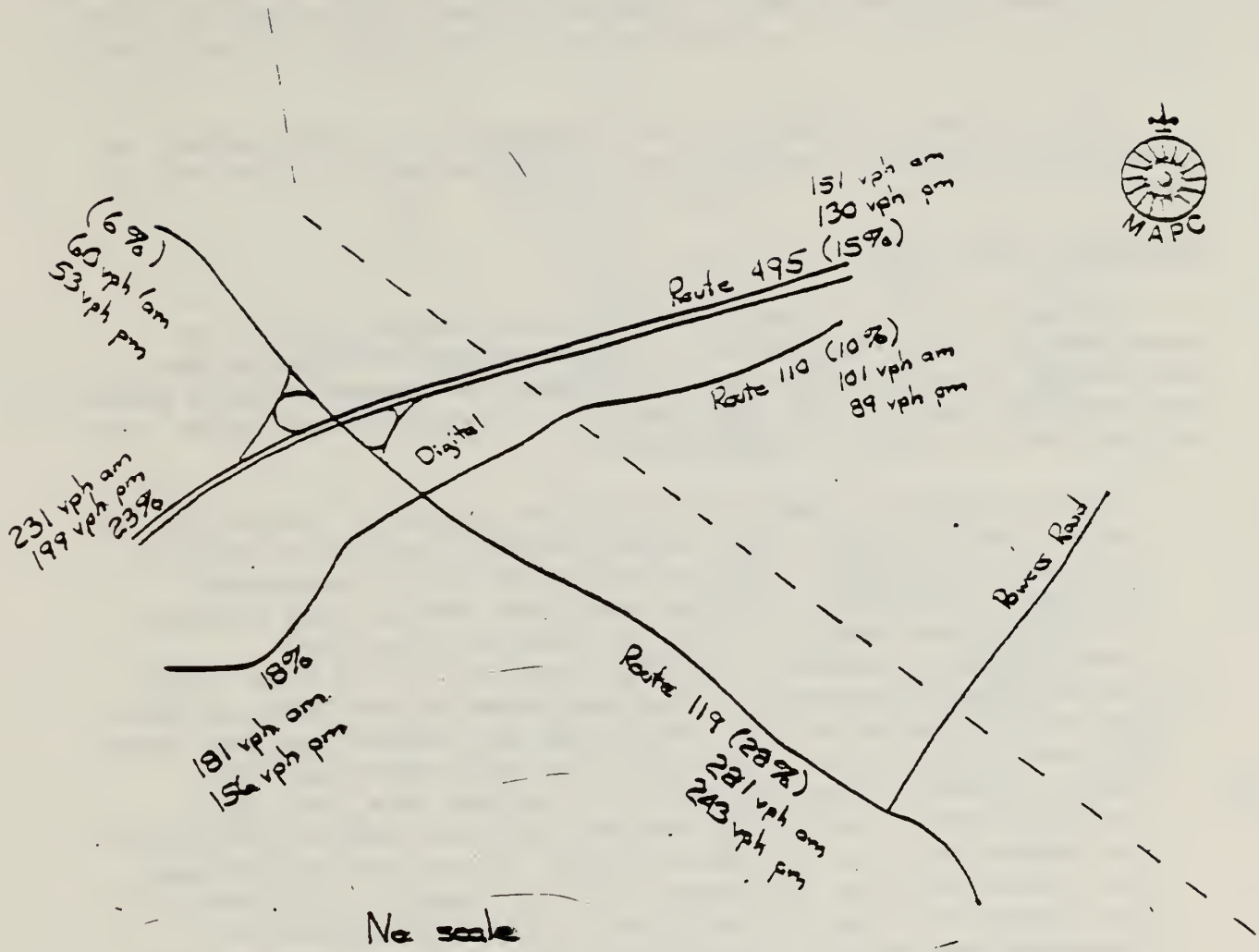


Figure 4-L
Distribution of Trips to Digital

Daily Trips:	5,940
Morning Peak Hour:	1,004 (16.9%)
Evening Peak Hour:	867 (14.6%)

It appears that a development such as Digital will generate approximately 12 trips per day per thousand square feet of floor area (ksf). Using a factor of 12 trips per day per ksf, it is expected that the Digital facility, at 495 ksf will generate approximately 5,940 trips per day. Figure 4-L shows the assumed distribution of these trips based on the Digital EIR.

New developments in Westford will add 3560 more trips per day to Littleton roads. These trips will travel along Route 119 south of Powers Road and east on Powers Road to Westford, as well as through the Common area. Figure 5-L shows the distribution of these trips, as developed by NMAC.

Trips in 1990 to Digital at the Common and to new developments in Westford are assumed to be distributed along Route 110 to the west as shown in Figure 6-L.

Estimated 1990 Traffic

Traffic in 1990 is assumed to be related to the trips to new developments referred to above and also to growing traffic on the surrounding system. The following discussion of general traffic growth in the area from the Draft EIR for Westford Technology Park provides some perspective on background traffic growth.

> "There has been a relatively significant amount of traffic growth within the study area over the past several years as a result of economic development. This growth can be seen by reviewing historical (1978-1983) traffic count data for the area roadways. Analyzing these traffic volume data obtained from the Massachusetts Department of Public Works as well as from recent traffic studies conducted in the area revealed that daily traffic has been increasing at an average rate of 5 percent per year over the past several years. The data also shows that peak hour traffic appears to be increasing at a slower rate than daily traffic growth. The average morning peak hour annual growth rate was determined to be 3.1 percent while the average evening peak hour growth rate was estimated to be 3.4 percent. The lower peak hour growth rates may be explained by the area's growth in population and housing units. The towns of Acton, Littleton and Westford experienced an increase in population from 1970 to 1980 of 9 to 30 percent. Housing units increased over the same period by 22 to 50 percent. As population and housing units increase, the likelihood of more discretionary travel (non-work related) during off-peak hour exists. As a result, a higher annual growth rate in daily traffic may occur when compared to peak hour traffic growth."*

Based on this information, a 3.5 percent annual growth in background traffic during peak hours has been assumed.

*Vanasse/Hangen Assoc., Draft Environmental Impact Report for Westford Technology Park. (September, 1983).

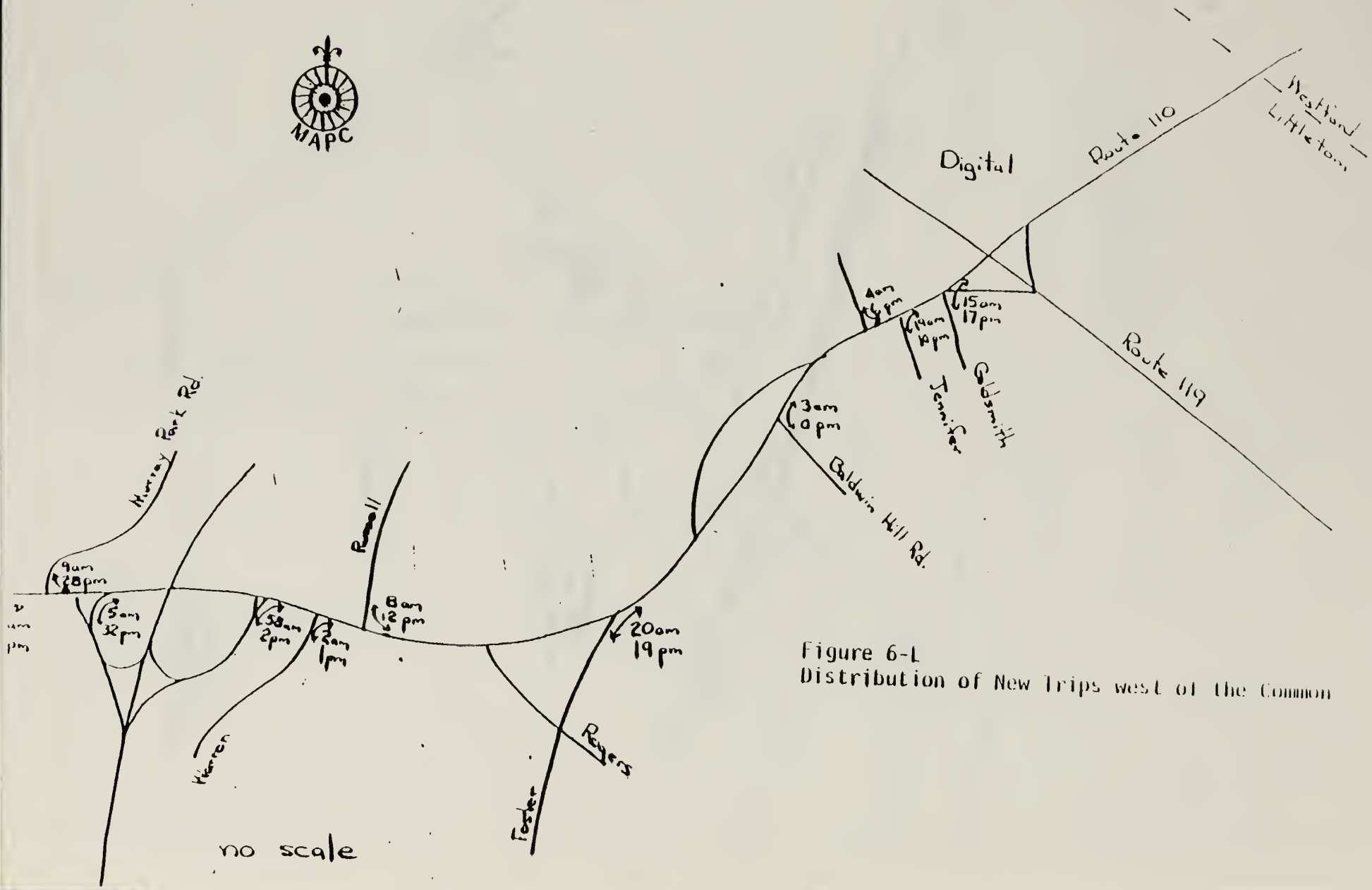


Figure 6-L
Distribution of New Trips west of the Common

Daily Trips:	3,560
Morning Peak Hour	726
Evening Peak Hour	700

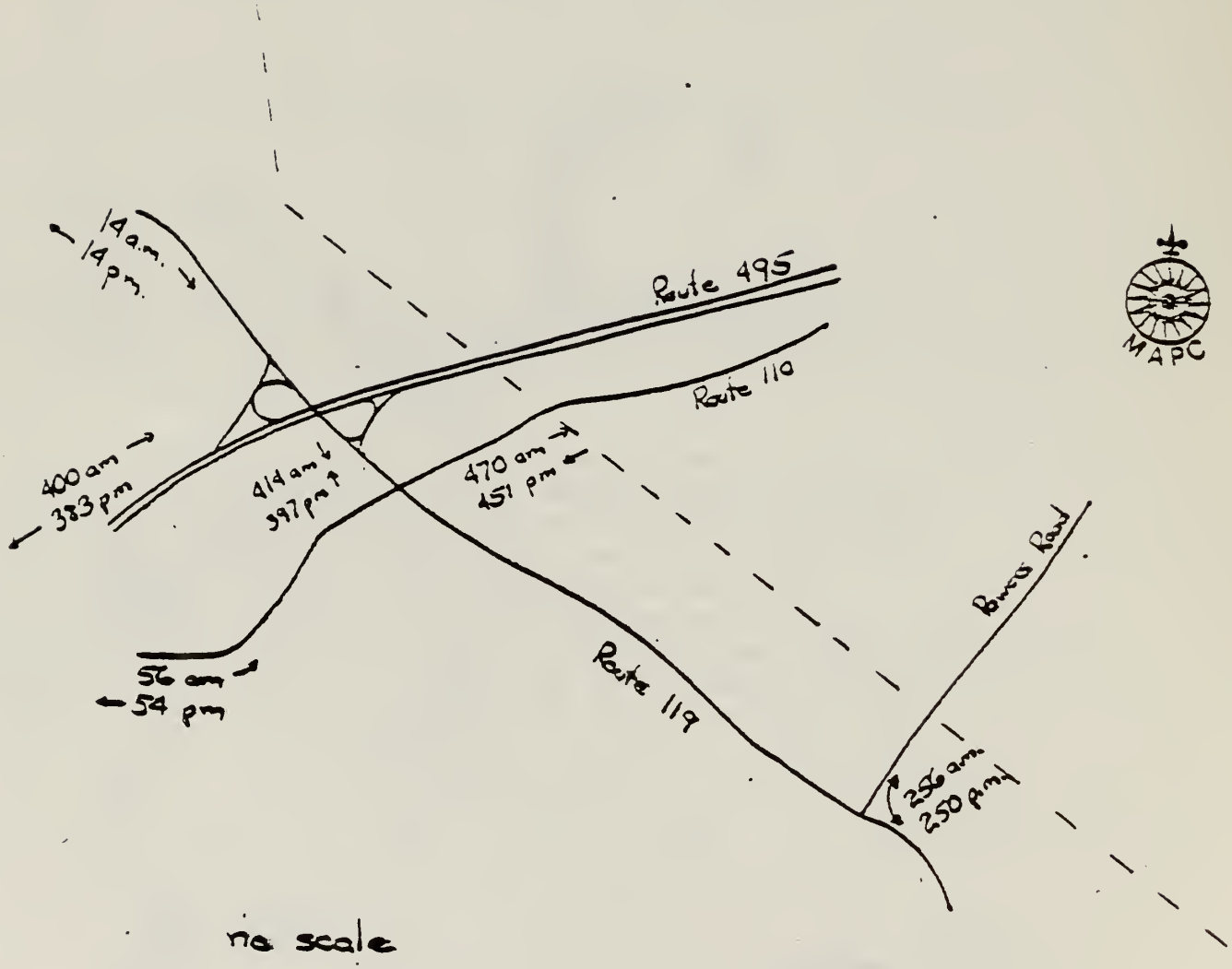


Figure 5-L
Distribution of Trip to New Destinations in Westford.

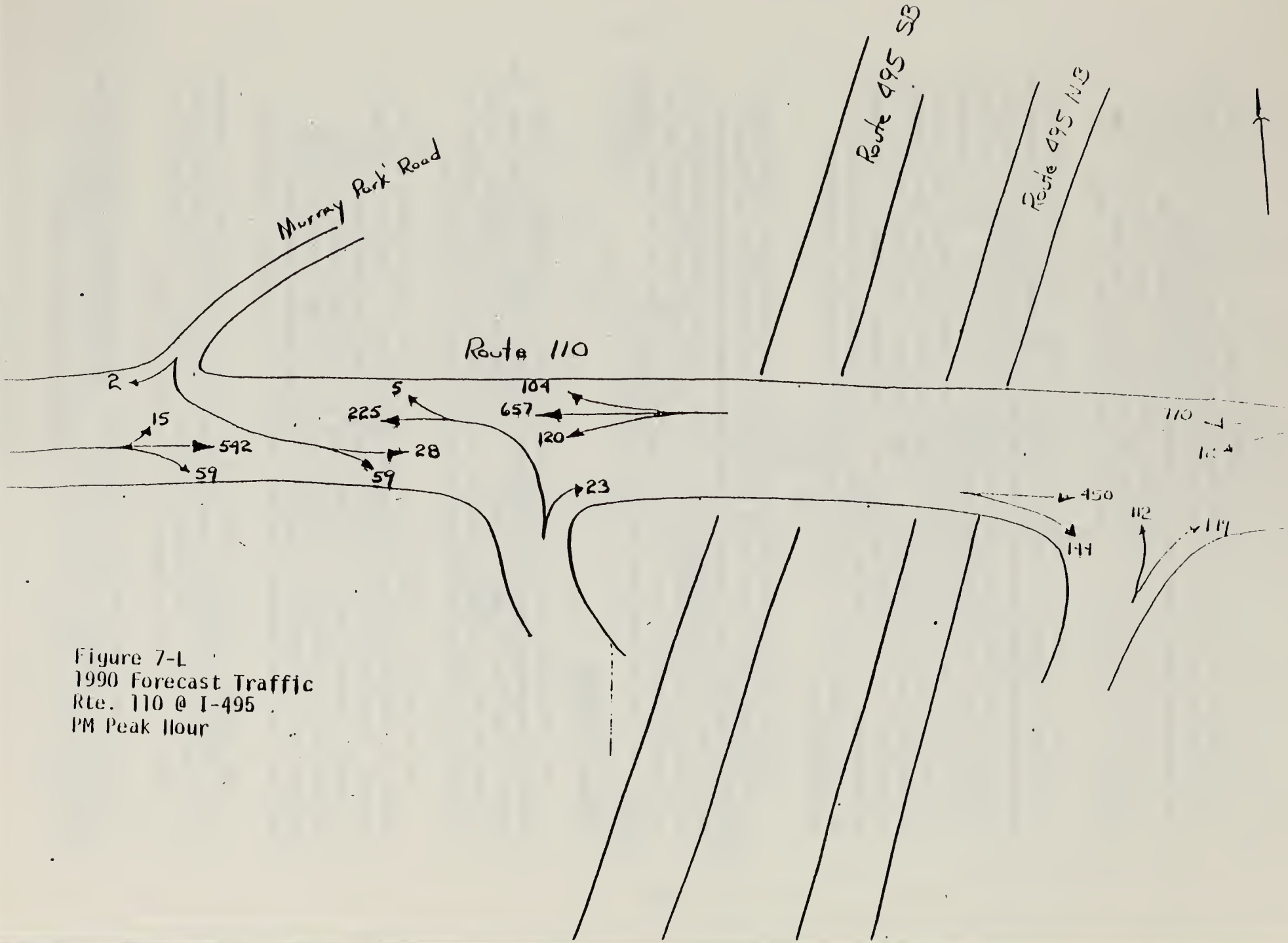


Figure 7-L
1990 Forecast Traffic
Rte. 110 @ I-495
PM Peak Hour

Traffic from Digital at Littleton Common and traffic from new developments in Westford have been added to projected 1990 background traffic. The resulting 1990 traffic forecasts are shown in figures 7-L through 11-L. West of the Common area, forecasts and analysis are presented for the evening peak hour only, since morning peak traffic is substantially lighter and predominant movements in the morning do not conflict as severely as during the p.m. peak.

It may be useful to compare these volumes with those developed in the Digital EIR and with those assumed in the design of intersection improvements about to be implemented at Littleton Common. Traffic forecasts were developed for the Digital EIR in 1981, based on 1980 traffic counts and growth expectations at that time. Trip generation from Digital was estimated at 8.36 rather than 12 trips per day per ksf, as discussed above. Substantial traffic from new developments in Westford was not included in that analysis. And the one-way flow on Stevens and Meetinghouse was not anticipated. With all of these differences, it is not surprising that forecasts in the Digital EIR for the "future year" are not comparable to traffic estimates presented here.

Traffic volumes used in the design of intersection improvements at the Common are compared in Table 2-L with estimates developed here. Clearly, there is a difference between estimates of current and future traffic on Route 110. Given that MAPC estimates are developed from 1983 traffic counts at the Common and substantiated by 1984 traffic counts just west of the Common, there is no doubt the older traffic projections are outdated.

LEVEL OF SERVICE

The implications of the preceding traffic projections and the following capacity analysis are expressed as level of service and the ratio of traffic volume to roadway or intersection capacity. Level of service and volume to capacity (v/c) ratios are the standards of reference in evaluating the efficiency of traffic operations.

The volume to capacity ratio results from the division of the volume of traffic by the estimated capacity of a location. Level of service decreases from A to F as the v/c ratio approaches 1.00. A v/c ratio greater than 1.00 indicates traffic in excess of the capacity of the facility. Thus, there is a direct relationship between the v/c ratio, a numerical representation, and level of service, which expresses the same concept of operating efficiency.

For roadway sections, level of service may be related to average travel speed as well as to qualitative descriptions of traffic flow (in terms fluidity, stability) and the v/c ratio. A description of the level of service categories for roadways follows:*

* Institute of Transportation Engineers, Transportation and Traffic Engineering Handbook, Second Edition, 1982; and Transportation Research Board, Special Report 87, Highway Capacity Manual, Washington, D.C., 1965.

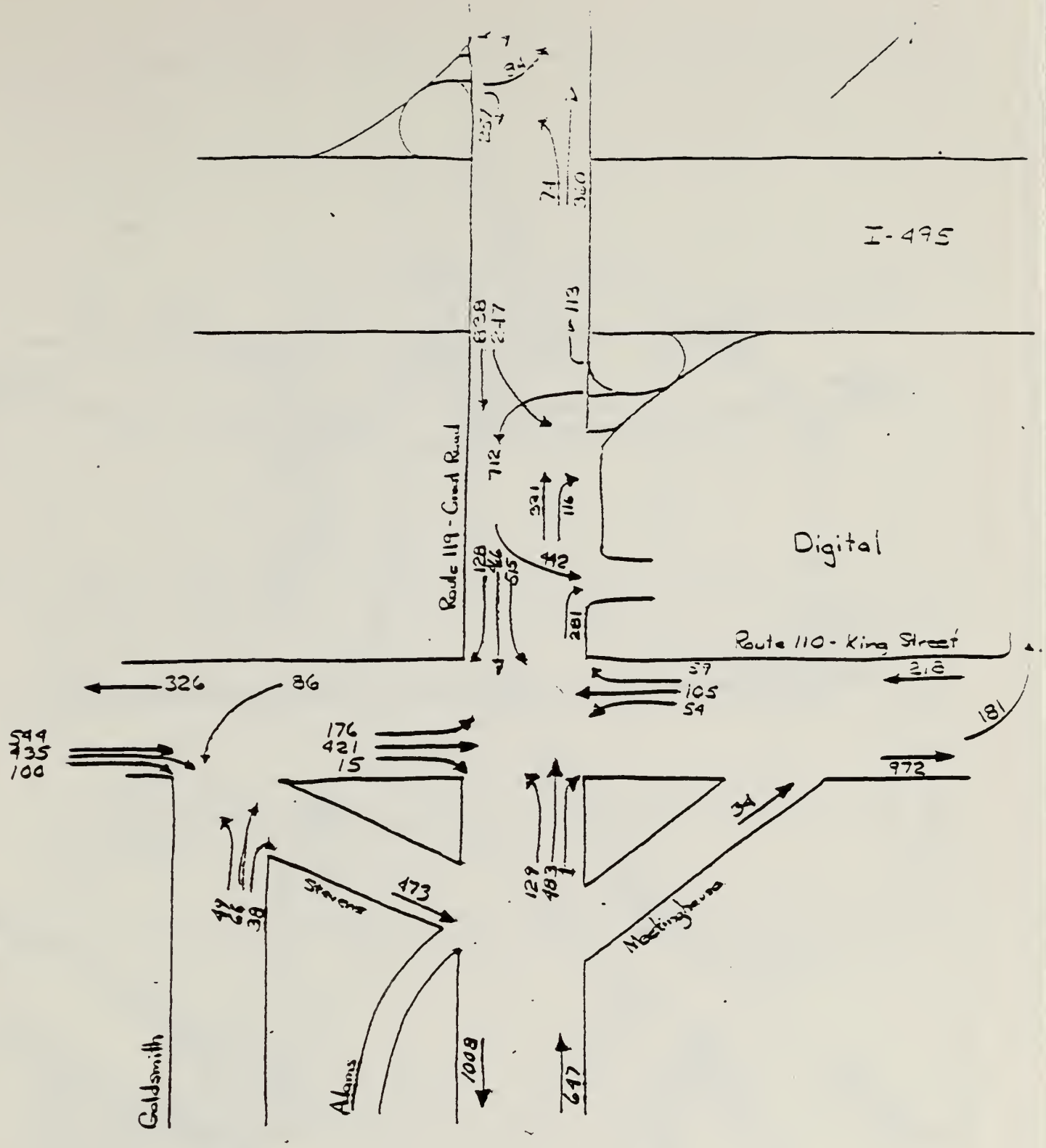


Figure 9-L
1990 Forecast Traffic
Littleton Common Area
AM Peak Hour

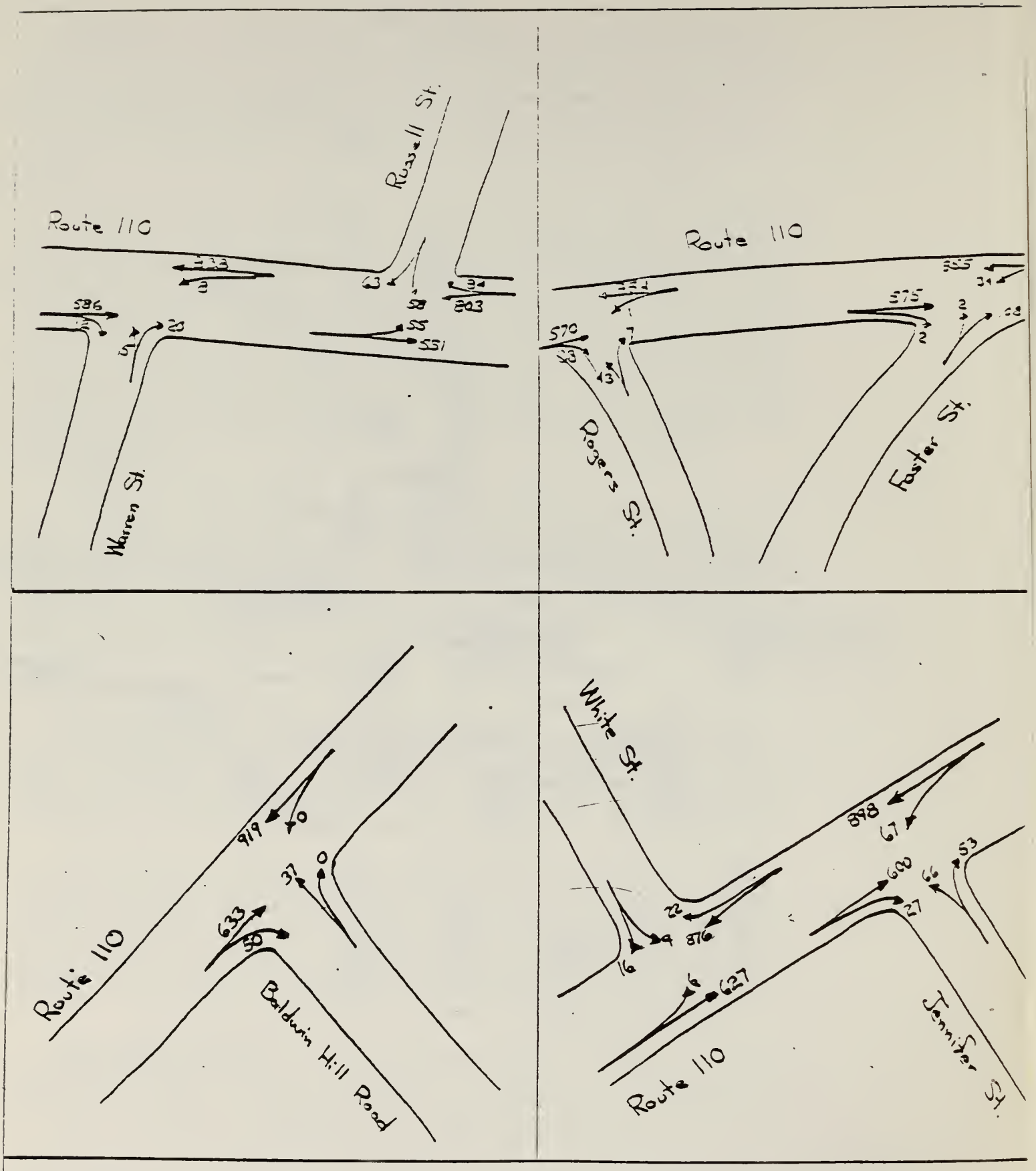


Figure 8-L
1990 Forecast Traffic
Rte. 110 from Warren St. to Jennifer St.
PM Peak Hour

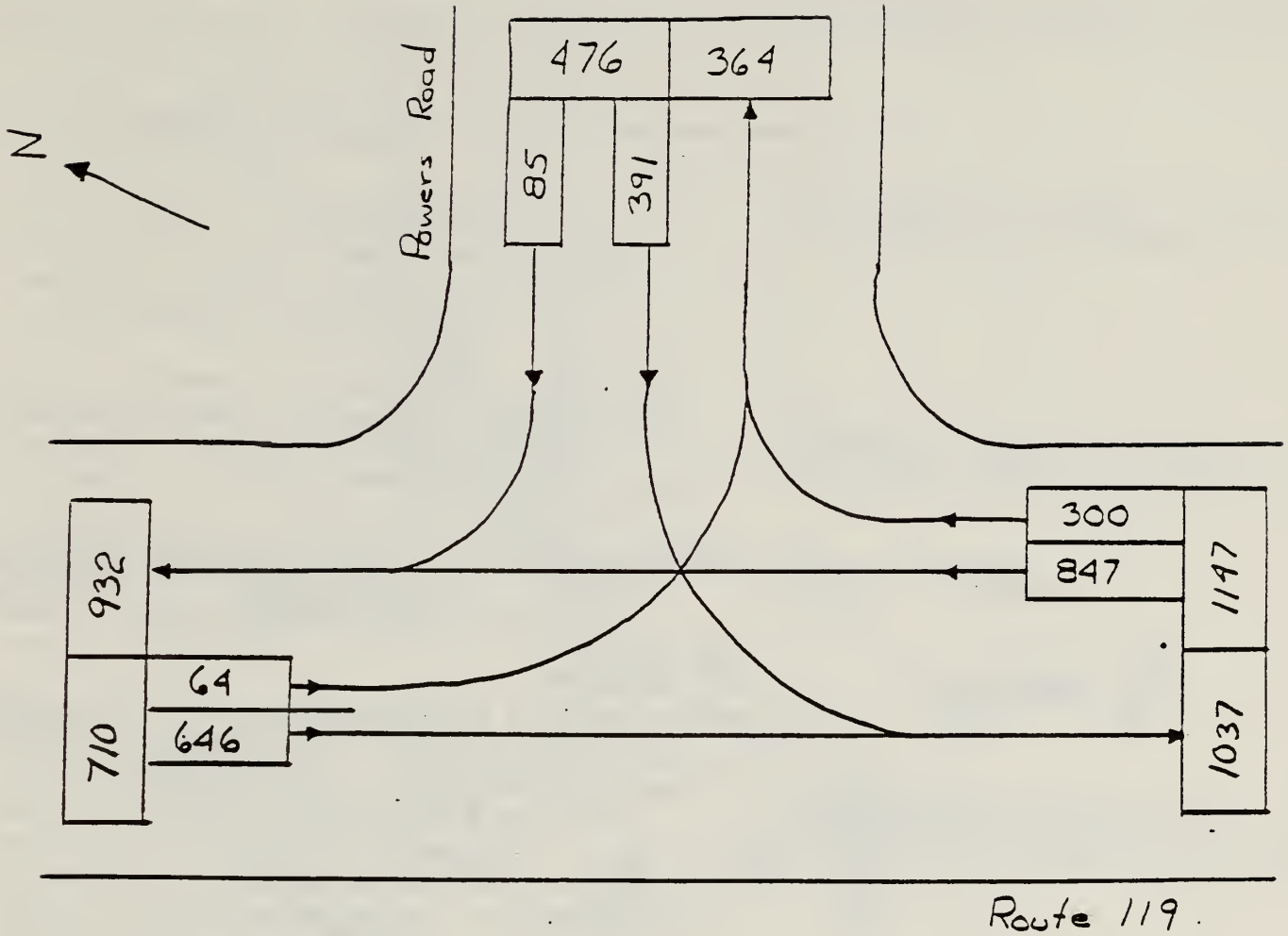


Figure 11-L
1990 Forecast Traffic
Route 119 @ Powers Road
PM Peak Hour

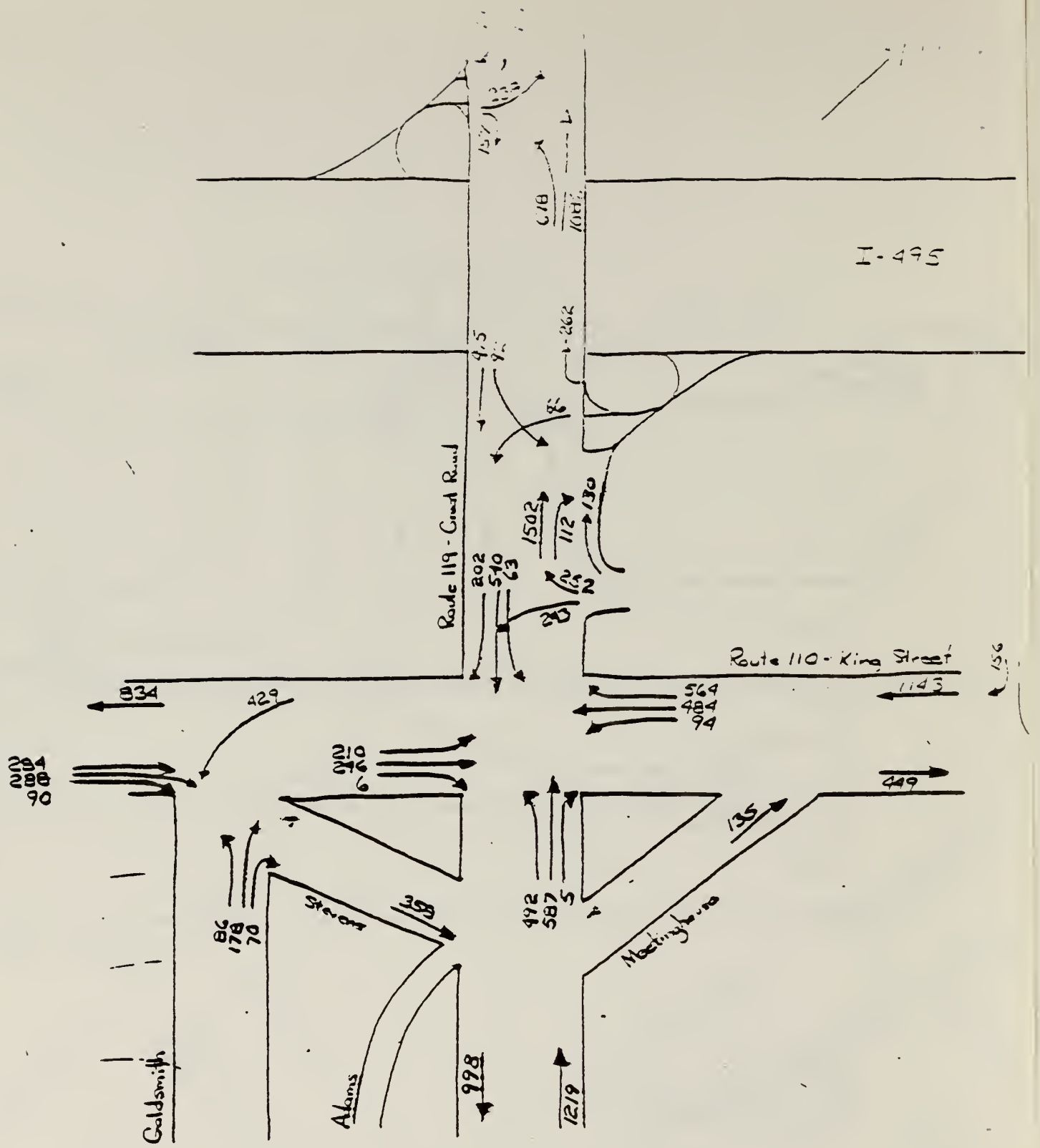
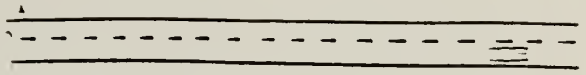
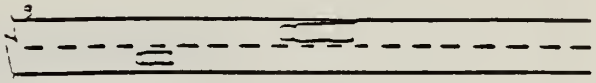


Figure 10-L
1990 Forecast Traffic
Littleton Common Area
PM Peak Hour

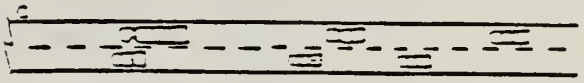
LOS A - The highest quality of service a particular class of highway can provide. It is a condition of free flow in which there is little or no restriction on speed or maneuverability caused by the presence of other vehicles. Average travel speed ≥30 mph. Volume/capacity ratios are ≤.50.



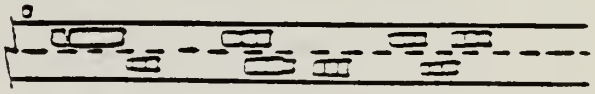
LOS B Stable flow. Operating speed is beginning to be restricted by other traffic. Average travel speed ≥25 mph. Volume/capacity ratios are ≤.70.



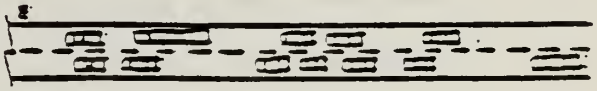
LOS C Still a zone of stable flow, but this service level is frequently selected as being appropriate threshold for design purposes. Average travel speed ≥20 mph. Volume/capacity ratios are ≤.80.



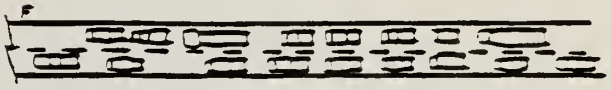
LOS D Approaches unstable flow. Tolerable operating speeds are maintained, but are subject to considerable and sudden variation. Freedom to maneuver and driving comfort are low, and the probability of accidents has increased. Most drivers would consider this LOS undersirable. Average travel speed ≥15 mph. Volume/capacity ratios are ≤.90.



LOS E The upper limit of LOS E is the capacity of the facility and operation at this LOS is unstable. Since headways are short (distance between vehicles) and operating speeds subject to rapid fluctuation, driving comfort is low and accident potential is high. Average travel speed approximately 15 mph. Volume/capacity ratios are ≤1.00.



LOS F Forced flow conditions. Speed and rate of flow are below levels attained in LOS E and may, for short periods of time, drop to zero. Volume/capacity ratios are not meaningful at LOS F.



Capacity for a road section is estimated from lane width, number of lanes, lateral clearance, terrain and proportion of trucks.

For intersections, level of service relates to delays as well as v/c ratio, and has a slightly different meaning for signalized and unsignalized intersections.

Table 2-L

PM Peak Hour Traffic Estimates - Route 110 @ Route 119

	Route 119*	Route 110*
1984 MAPC traffic counts	1242/762	772/478
"current" Common design baseline	960	320
1990 MAPC Forecast	2166/1724	1640/1457
2000 Common design horizon	1703	408
Common design hour volume	1250	500

*Design plan does not specify where in the intersection this traffic is observed. MAPC traffic is tabulated for each side of the intersection: west/east and north/south.

Table 3-L

SIGNALIZED INTERSECTION LEVEL OF SERVICE*

Level of Service	Expected Traffic Delay	Sum of Critical Volumes		
		Two Phase	Three Phase	Four or more Phases
A	Little or no delay	1000	950	900
B	Short traffic delays	1200	1140	1080
C	Average traffic delays	1400	1340	1270
D	Long traffic delays	1600	1530	1460
E	Very long traffic delays	1800	1720	1650
	or			
E	Failure-extreme congestion			
F	Intersection blocked by external causes	------not applicable-------		

* Transportation Research Circular Number 212, January 1980, Transportation Research Board, National Academy of Sciences.

For a signalized intersection, the traffic volume of interest is actually the sum of the traffic volumes which conflict during each of the signal phases. Table 3-L shows a correlation between expected delays, level of service and the sum of critical (conflicting) volumes. Capacity is indicated by the sum of critical volumes at level of service E.

For an unsignalized intersection, it is difficult to establish one level of service for the intersection as a whole. It often happens that the traffic entering and leaving the minor street experiences significant delays while traffic on the major street flows with little or no disturbance. Accordingly, capacity calculations for minor approaches are based on the length and frequency of gaps in conflicting traffic flow. Table 4-L shows the relationship between the capacity of each approach, volume on that approach and level of service.

CAPACITY ANALYSIS

The capacity of Route 110 and other streets in the study area is related to the geometry of the intersection and traffic conflicts, as well as characteristics of the roadway between intersection. This study has pointed out that capacity problems on Route 110 in Littleton will be at intersections rather than on the sections of roadway between intersections.

The capacity of Route 110 between intersections is estimated as a function of roadway width, lateral clearance, terrain, and truck volumes to be 1800 to 1900 vehicles per hour (vph).* For 1984, the heaviest traffic observed was 56 to 61 percent of that, indicating level of service (LOS) A. By 1990, traffic is expected to reach 83 to 91 percent of capacity over some segments, indicating LOS C. Lighter traffic on other sections will result in LOS B.

Intersection capacities are much more critical. Results of the capacity analysis, which evaluated each intersection and interchange in the study area are summarized in Tables 5-L and 6-L. Looking at the column showing volume to capacity ratios, it is clear that traffic volumes anticipated in 1990 will not flow smoothly through the system.

The focus of attention in this analysis is the Littleton Common Area, which will serve a large amount of traffic from the new Digital facility and from development in Westford.

The intersection of Routes 110 and 119 (the Common), assuming planned improvements as shown in figure 2-L will function at level of service D or E during the 1990 a.m. peak hour. But it is expected to fail, with 55% more traffic than it can carry, during the 1990 p.m. peak. It is important to note that this recently redesigned intersection will not be adequate six years from now.

Egress from Digital will be a severe problem if built as designed. With one lane exiting from Digital to Route 110 and no signal, p.m. peak hour traffic will exceed capacity by 96 percent. At Route 119, with two exiting lanes, even adding a signal will not meet the needs of estimated traffic, which would exceed the capacity of a signalized intersection by 16 percent in the p.m. peak hour.

Table 5-L

Signalized Analysis for High - Volume Intersections

Intersection	Year	Peak hour	v/c*	Level of Service	Comment
SIGNALIZED INTERSECTIONS					
Route 110 @ Route 119	1984	PM Peak	.70	B	Existing intersection layout
	1990	AM Peak	.94	D-E	See Figure 2-L
	1990	PM Peak	1.55	E-F	See Figure 2-L
UNSIGNALIZED INTERSECTIONS AS THEY WOULD FUNCTION IF SIGNALIZED					
Route 110 @ Digital	1990	PM Peak	.56	A	See figure 2-L
Route 119 @ Digital	1990	AM Peak	1.01	E-F	See Figure 2-L
		PM Peak	1.16	E-F	See figure 2-L
Route 119 @ I-495 NB	1990	AM Peak	1.36	E-F	
SB	1990	PM Peak	1.89	E-F	
Route 110 @ Goldsmith, Stevens	1990	AM Peak	.86	D	See Figure 2-L
	1990	PM Peak	.95	D-E	See Figure 2-L
Route 110 @ I-495 SB & Murray Park Road	1990	PM Peak	.98	E	Assumes simple 4-way intersection

*Ratio of traffic volume to intersection capacity

Table 4-L

Levels of Service for Unsignalized Intersections

(minor street)

Reserve Capacity	Level of Service	Expected Traffic Delay
400 or more	A	Little or no delay
300 to 399	B	Short traffic delays
200 to 299	C	Average traffic delays
100 to 199	D	Long traffic delays
0 to 99	E	Very long traffic delays
Less than 0	E	Failure-extreme congestion
(any value)	F	Intersection blocked by external causes

The difference between capacity and volume is reserve capacity. The poorest level of service in the intersection is taken to imply the level of service for the intersection as a whole.

The system also breaks down at the I-495 interchange (only 400 feet away). Morning peak hour traffic at the northbound exit ramp will exceed capacity by 36 percent due to a very heavy left turn from the ramp. Evening peak hour traffic at the southbound ramp will exceed capacity by 89 percent due to a very heavy left turn from Route 119 to I-495 SB. It is important to note that the queues at failing intersections have the potential to bring traffic to a halt on Route 119 from the Common to I-495.

Also on Route 119, the intersection at Powers Road is a problem. Already at 47 percent over capacity, there is not a sufficient number of safe gaps in Route 119 traffic to accommodate turning traffic. Traffic is expected to increase to a level far beyond the capacity of an unsignalized intersection.

On Route 110, the intersection at Goldsmith and Stevens will be congested. If a signal is installed by 1990, the intersection may operate at LOS D, or possibly E in the p.m. peak. Jennifer Street will be over capacity by 46 percent during the p.m. peak hour. Baldwin Hill Road will have significant traffic by 1990, operating near capacity. Other intersections between Jennifer Street and I-495 on Route 110 are lightly travelled, volume to capacity ratios range from 0.2 to 0.3.

At the I-495 interchange with Route 110 traffic conflicts also reach an unsatisfactory level. At the northbound ramps, heavy p.m. peak traffic may prevent vehicles from I-495 from entering the traffic stream. At the other side of the interchange, heavy left turns from Route 110 to I-495 SB, together with other conflicting movements, will lead to failure without signal control. With signal control, and assuming a simple 4-way intersection, level of service E can be expected.

Taken altogether, these results indicate an urgent need to address capacity deficiency problems in the study area.

*Highway Research Board, Highway Capacity Manual (1965) p. 309,

CWB/cmw
10/84

Table 6-L

Level of Service for Minor Streets at Unsignalized Intersections

(PM Peak Hour)

Major St	Minor St.	Year	Volume/ Capacity*	Capacity Deficiency*	Reserve Capacity*	Level of Service*
Route 110	@ Digital	1990	2.0	132 vph		E-F
Route 119	@ Powers Road	1984	1.5	65 vph		E
		1990	6.1	360 vph		E
Route 110	@ Jennifer Street	1984	0 5		111 vph	D
		1.90	1.5	41 vph		E
Route 110	@ Murray Park Road	1990	2.3	68 vph		E-F
Route 110	@ I-495 SB ramps	1990	3.5	198 vph		E-F
Route 110	@ I-495 NB ramps	1990	1.5	43 vph		E
Route 110	@ Warren Street	1990	0.2		110 vph	D
Route 110	@ Russell Street	1990	0.3		323 vph	B
Route 110	@ Rogers Street	1990	0.8		178 vph	D
Route 110	@ Foster Street	1990	0.2		417 vph	A
Route 110	@ Baldwin Hill Road	1990	0.9		8 vph	E
Route 110	@ White Street	1990	0.3		120 vph	D

*These measure level of service on the minor approach. Capacity deficiency and reserve are expressed in vehicles per hour (vph.)

APPENDIX

Included here are traffic data used in this study to quantify traffic flow in the base year: 1984. MAPC and Littleton performed turning movement counts in June, 1984. And NMAC collected automatic traffic recorder data during the same month. Recent data available from other traffic studies was also utilized and is included here.

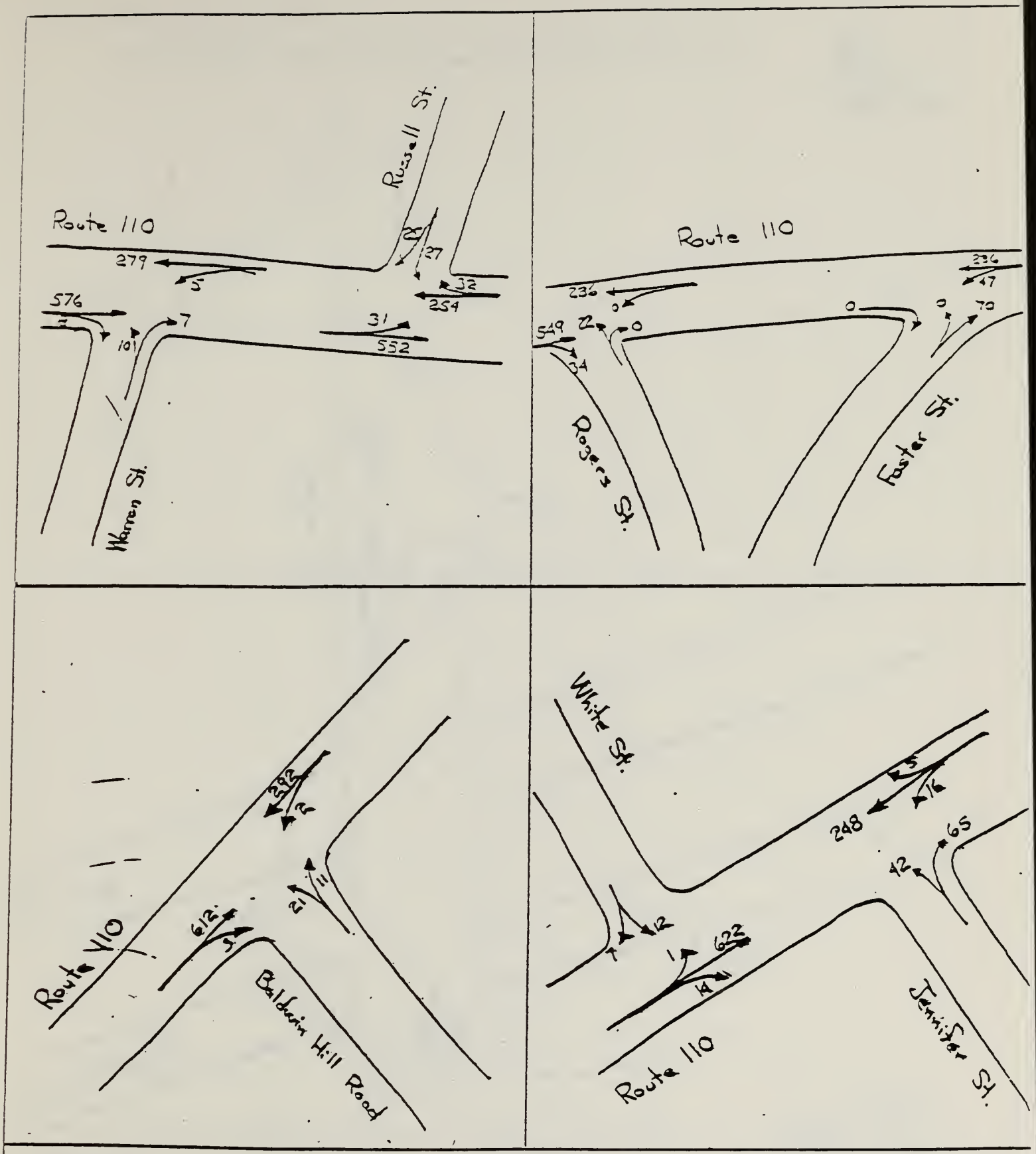


Figure B
Traffic Counts
June 6, 1984
7:45 AM to 8:45 AM
Route 110 - Warren Street to Jennifer Street

MAPC

Metropolitan Area Planning Council
110 Tremont Street Boston, Massachusetts 02108 (617)-451-2770

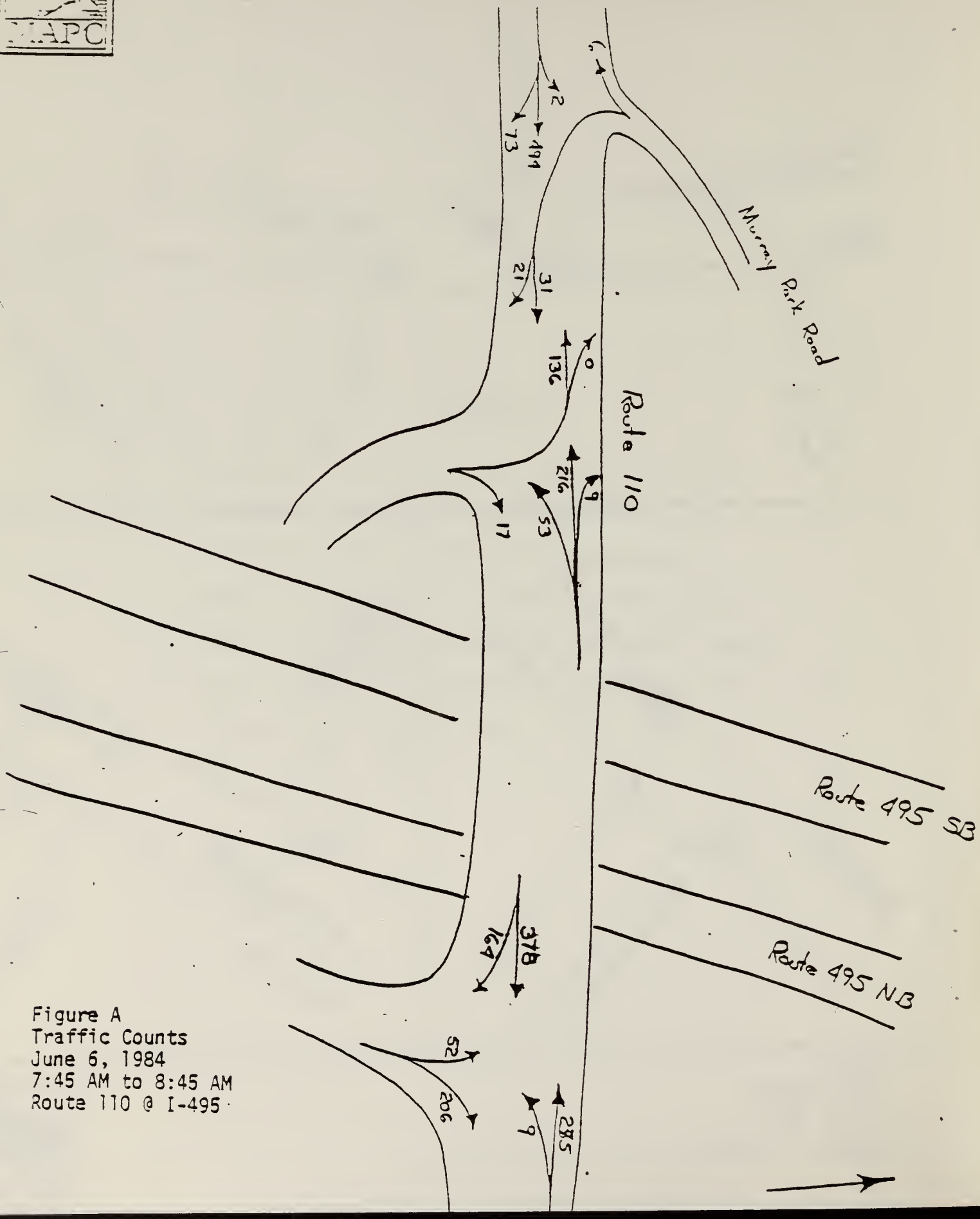


Figure A
Traffic Counts
June 6, 1984
7:45 AM to 8:45 AM
Route 110 @ I-495

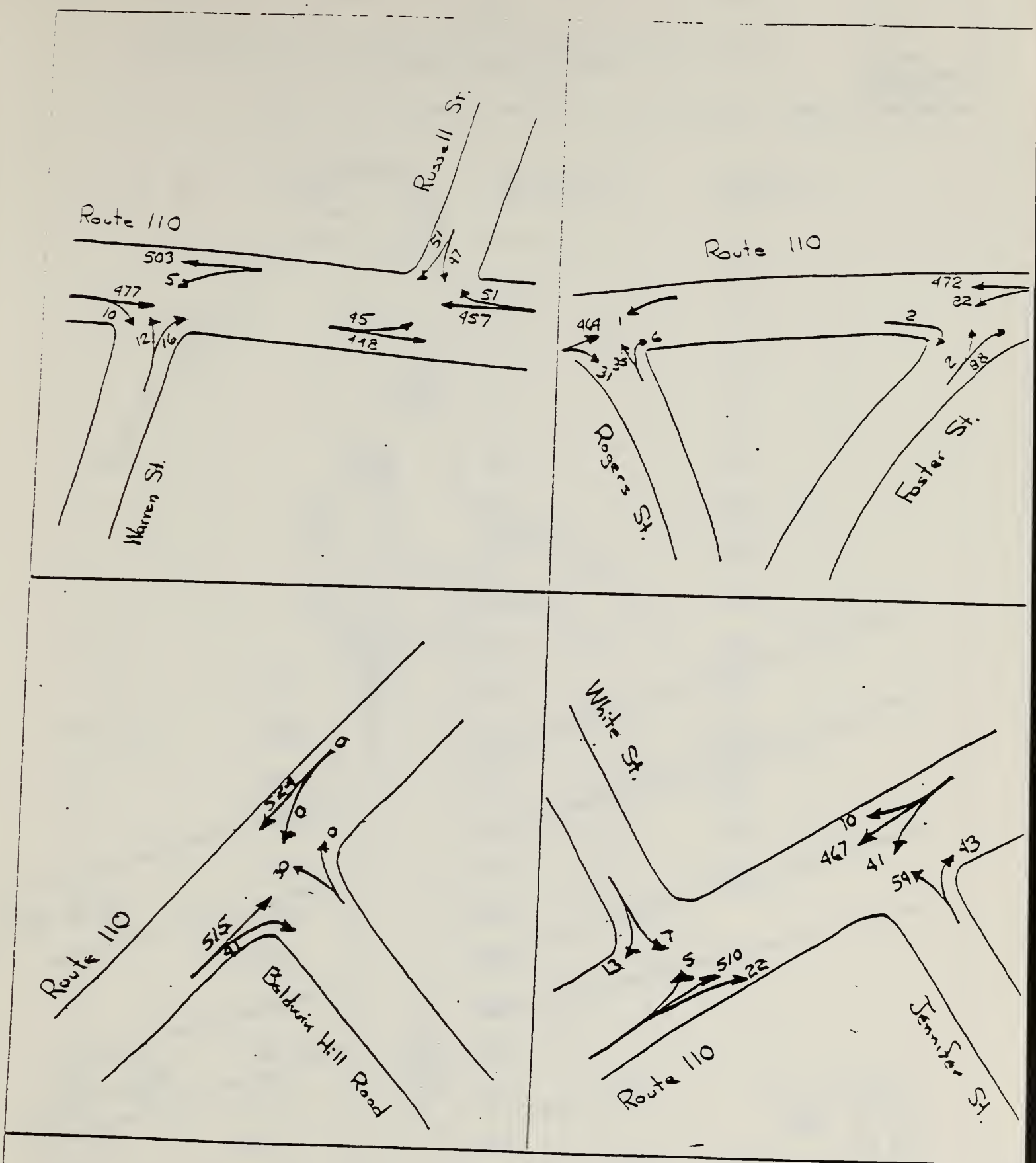


Figure D
Traffic Counts
June 6, 1984
5-6 PM
Route 110 - Warren Street to Jennifer Street

MAPC

Metropolitan Area Planning Council
110 Tremont Street Boston, Massachusetts 02108 (617)-451-2770
Serving 101 Cities & Towns in Metropolitan Boston

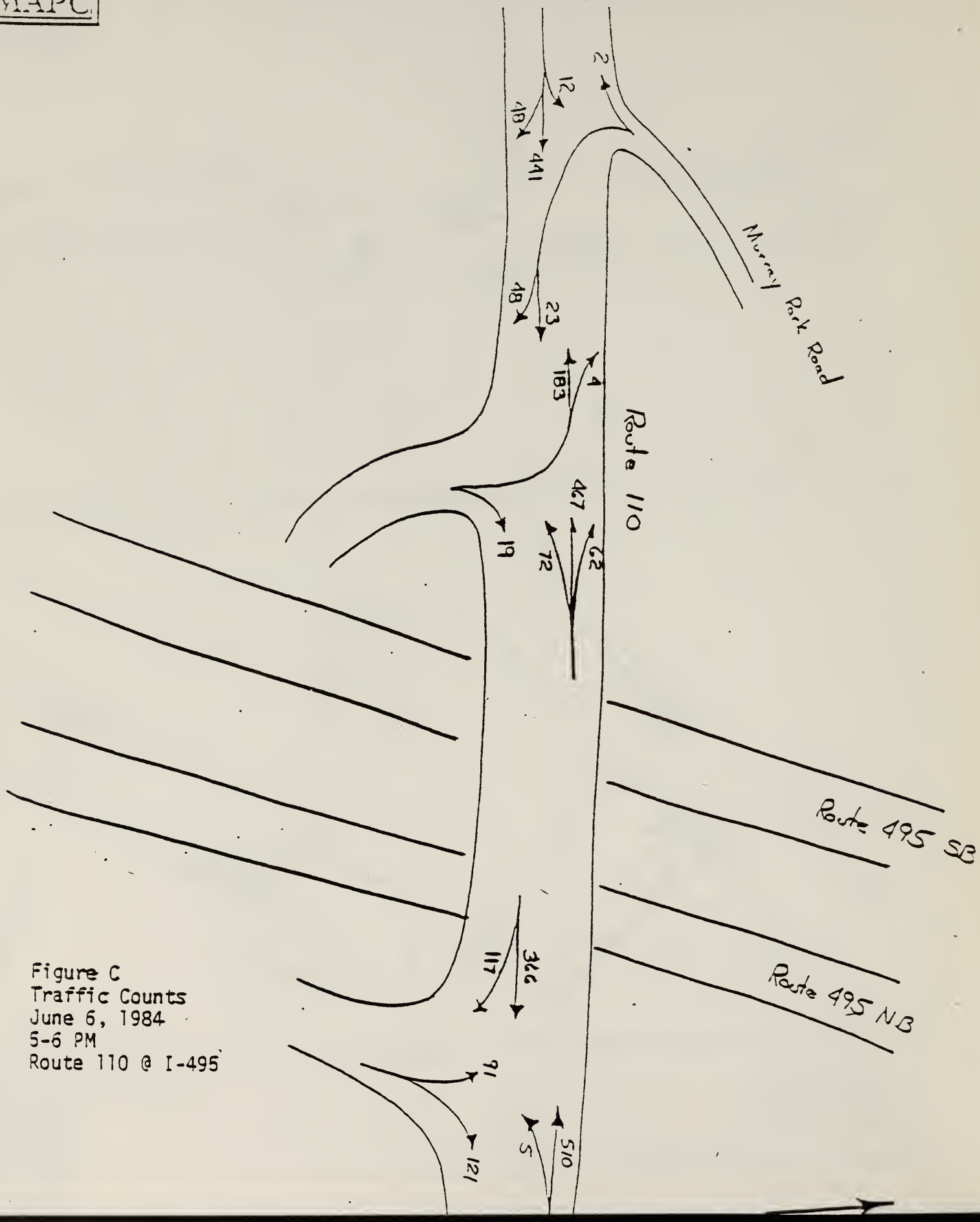


Figure C
Traffic Counts
June 6, 1984
5-6 PM
Route 110 @ I-495

Table F

Automatic Traffic Counts

Route 110 - Between Jennifer St. and Littleton Common

	Wed 6/20/84	Thurs 6/21/84	Fri 6/22/84
12-1 am		95	107
1-2		48	56
2-3		12	24
3-4		18	13
4-5		25	29
5-6		40	48
6-7		201	171
7-8		636	624
8-9		933	954
9-10		735	710
10-11		363	723
11-12	774	562	781
12-1 pm	976	967	1031
1-2	820	817	953
2-3	691	710	808
3-4	706	845	858
4-5	884	1095	
5-6	1092	1164	
6-7	881	1078	
7-8	681	830	
8-9	676	734	
9-10	561	564	
10-11	326	345	
11-12	201	199	
	9269	13016	7887

Table E

Automatic Traffic Counts

Route 110 - Jennifer Street and Littleton Common

June 6, 7, 8, 1984

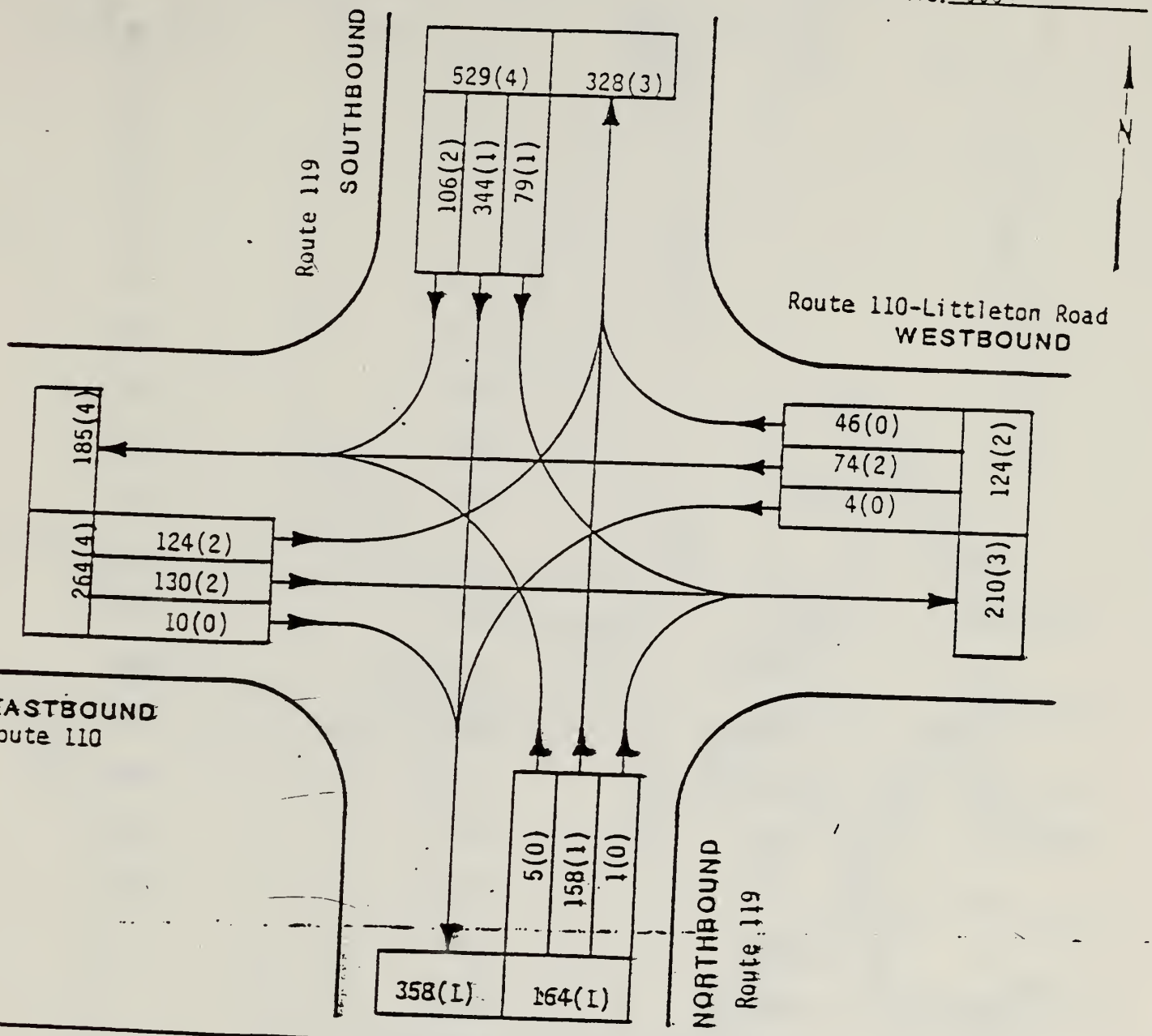
	Wed. 6/6	Thur. 6/7	Fri. 6/8
12-1 A.M.		115	101
1-2		44	52
2-3		14	35
3-4		26	23
4-5		29	33
5-6		68	70
6-7		375	336
7-8		889	841
8-9		861	988
9-10		712	840
10-11		710	724
11-12 P.M.		751	824
12-1		979	736
1-2		793	
2-3		854	
3-4		923	
4-5		1,045	
5-6	1,204	1,343	
6-7	884	853	
7-8	724	889	
8-9	676	654	
9-10	447	543	
10-11	270	333	
11-12 A.M	119	194	
	4,324	13,997	4,863

Figure H:
Turning Movement Counts - Littleton Common, AM Peak Hour 8/18/83

INTERSECTION TURNING MOVEMENT COUNT

CITY Littleton, MA. DATE 8/18/83 DAY of WEEK Thursday

INTERSECTION Route 119 & Route 110 JOB No. 0604



STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Route 119 (NB)	164(1)	15.2%	AM Peak Hour
Route 119(SB)	529(4)	48.9%	
Route 110(EB)	264(4)	24.4%	
Route 110 (WB)	124(2)	11.5%	7:15 to 8:15 AM
			VEHICLES COUNTED
			ALL VEHICLES XXX 1081
			TRUCKS (XX) 11
TOTAL	1081(11)	100.0%	PERCENT TRUCKS 1.0%

Source: Final Environmental Impact Statement for Westford Technology Park (December, 1983)

Table G

Automatic Traffic Counts

Route 110 Between I-495 NB exit and Warren St.

	Wed 6/20/84	Thurs 6/21/84	Friday 6/22/84
12-1 am		112	126
1-2		36	56
2-3		15	19
3-4		19	20
4-5		37	37
5-6		57	68
6-7		337	299
7-8		831	810
8-9		956	1012
9-10		809	745
10-11		639	760
11-12	827	803	866
12-1 pm	1016	973	1029
1-2	801	843	985
2-3	739	803	873
3-4	794	990	1015
4-5	1105	1204	
5-6	1338	1432	
6-7	985	1193	
7-8	785	839	
8-9	793	758	
9-10	614	605	
10-11	365	361	
11-12	187	284	
	10,349	14,856	8720

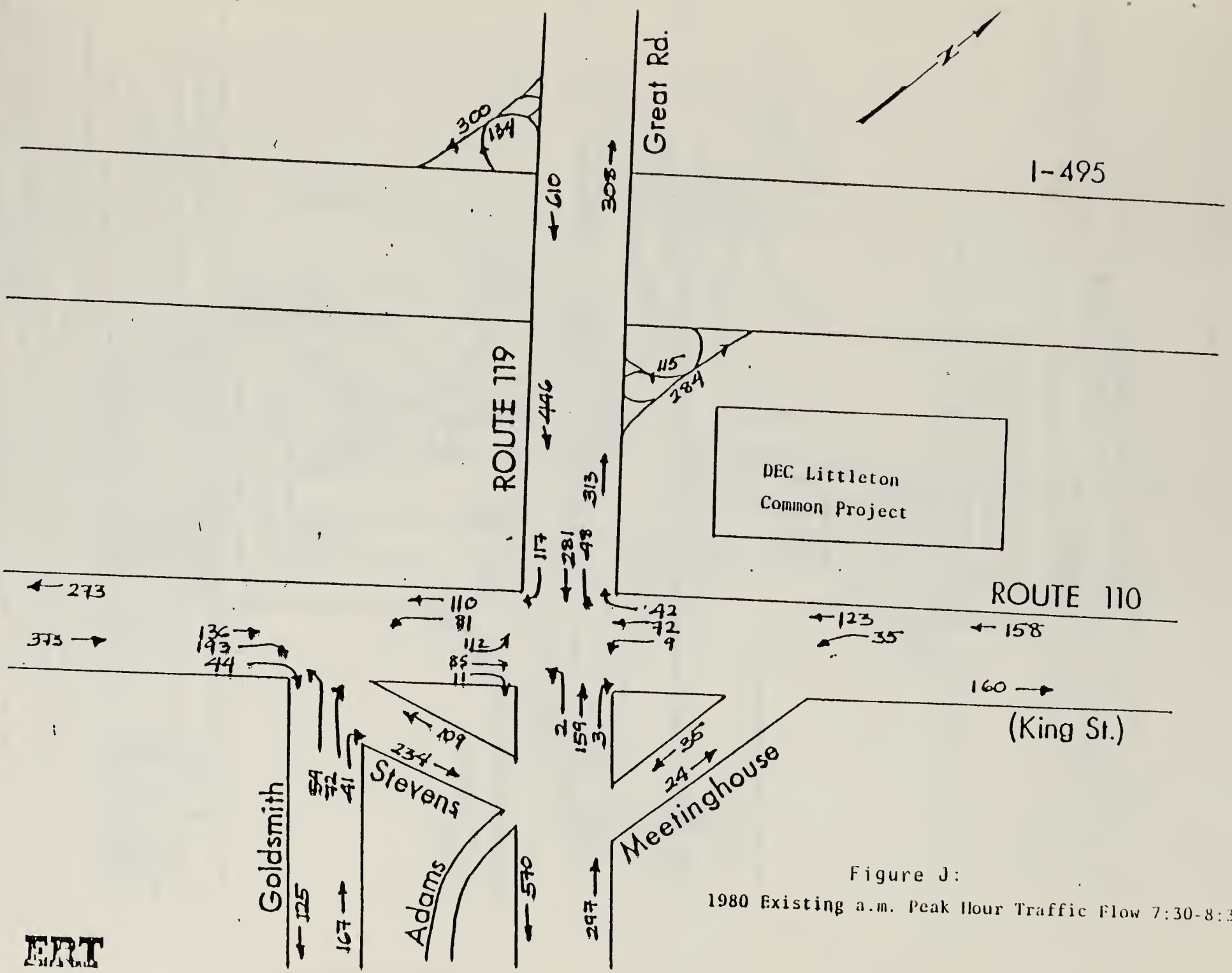


Figure J:
1980 Existing a.m. Peak Hour Traffic Flow 7:30-8:30

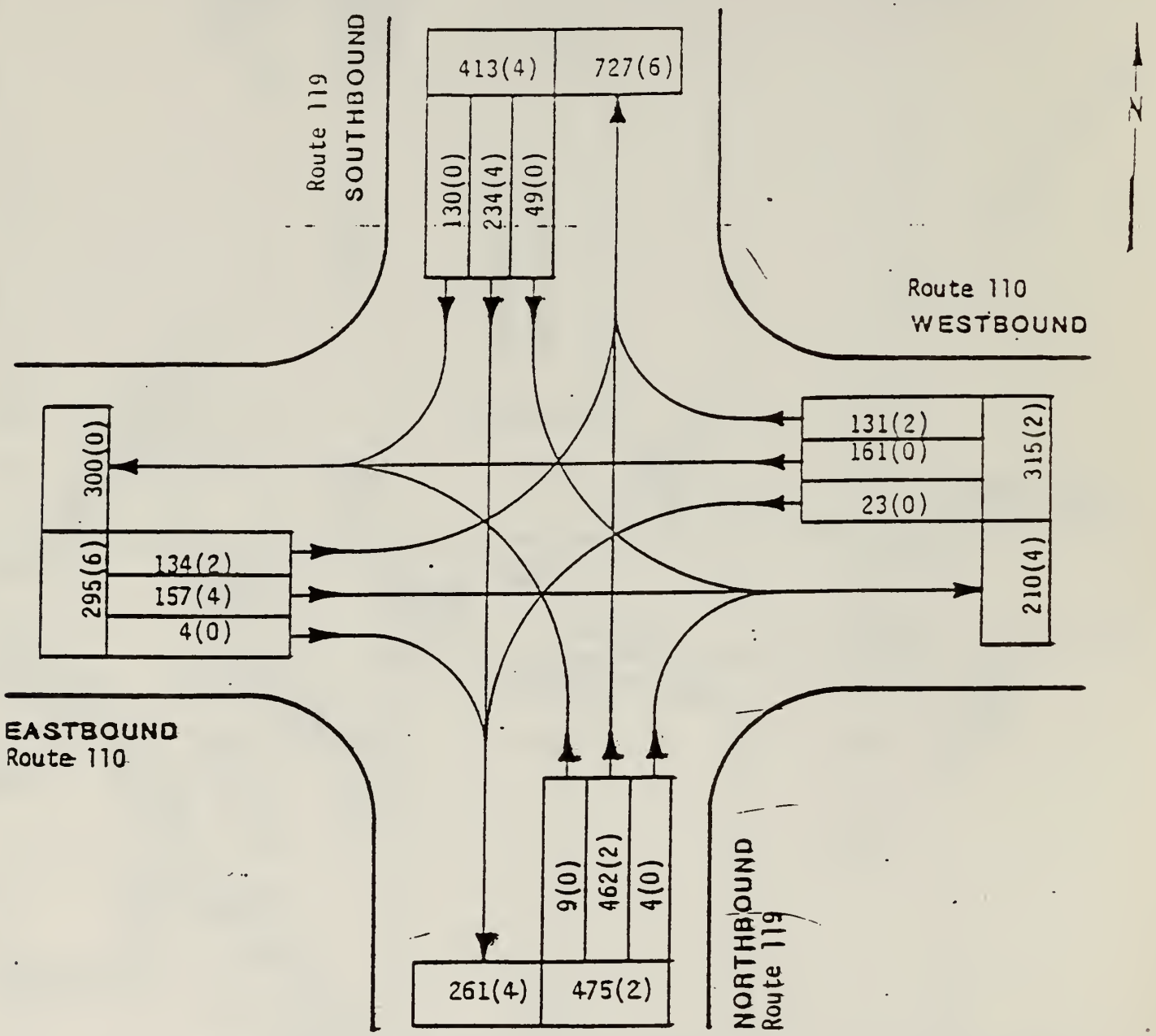
Source: ERT Field Counts

ERT

Figure I:
Turning Movement Counts - Littleton Common, PM Peak Hour 8/18/83

INTERSECTION TURNING MOVEMENT COUNT

CITY Littleton, MA. DATE 8/18/83 DAY of WEEK Thursday
INTERSECTION Route 119/Route 110 JOB No. 0604



STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Route 119 (NB)	475(2)	31.7%	PM Peak Hour
Route 119 (SB)	413(4)	27.6%	
Route 110 (EB)	295(6)	19.7%	4:45 to 5:45 PM
Route 110 (WB)	315(2)	21.0%	
			VEHICLES COUNTED
			ALL VEHICLES XXX 1498
			TRUCKS (XX) 14
TOTAL	1498(14)	100.0%	PERCENT TRUCKS 0.9%

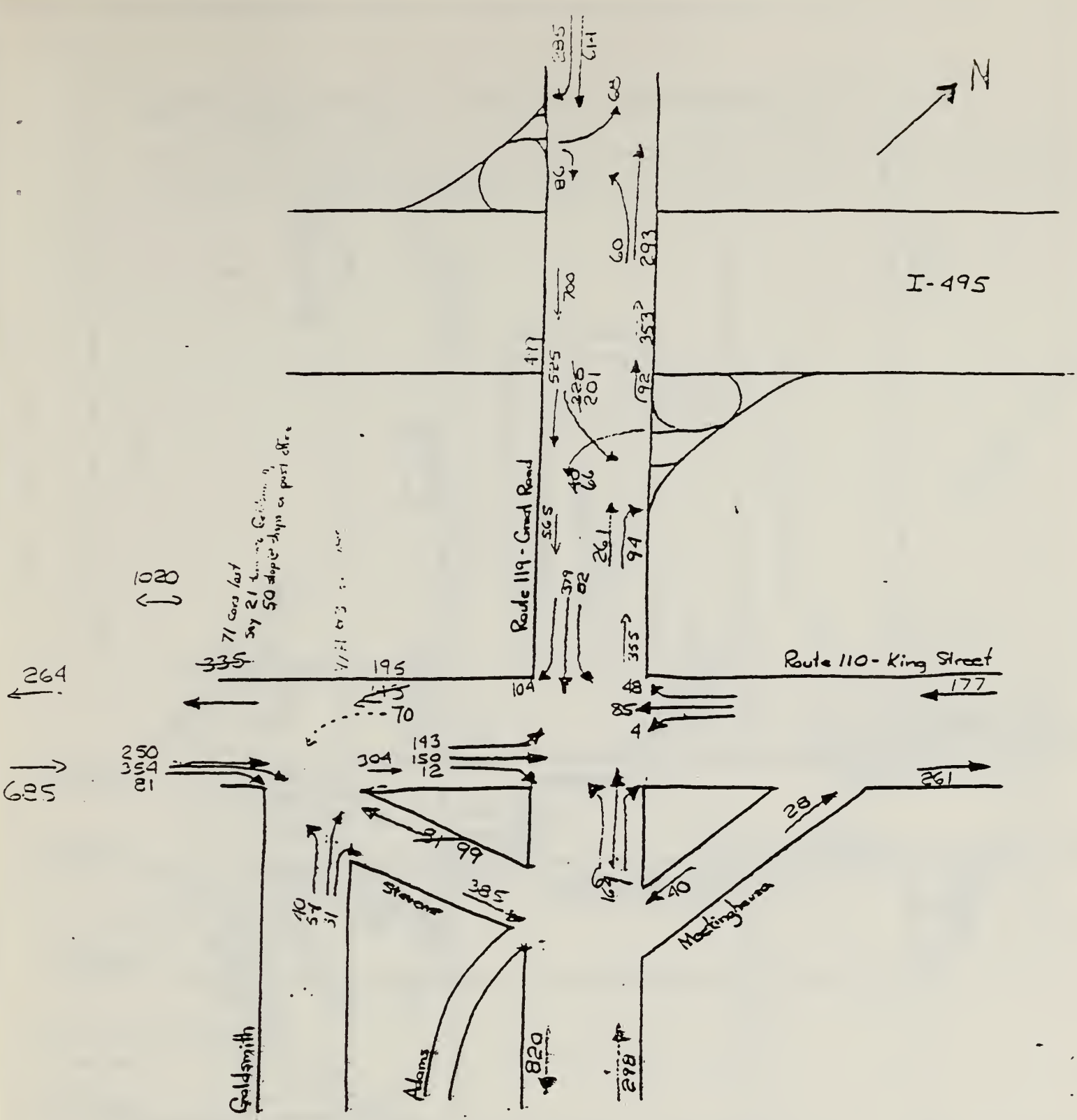


Figure L:
1984 AM Peak Hour Traffic at Littleton Common

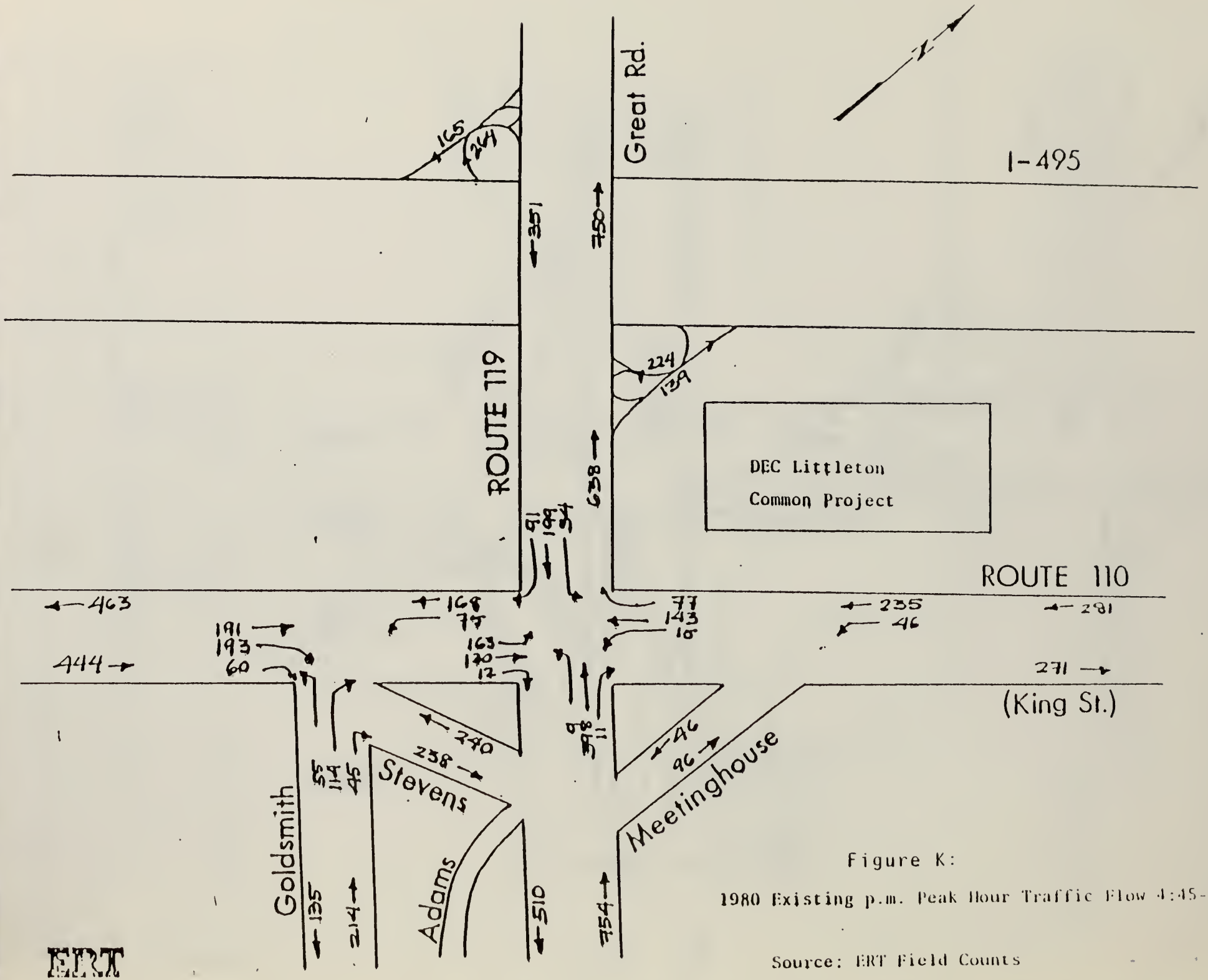


Figure K:

1980 Existing p.m. Peak Hour Traffic Flow 4:45-5:45

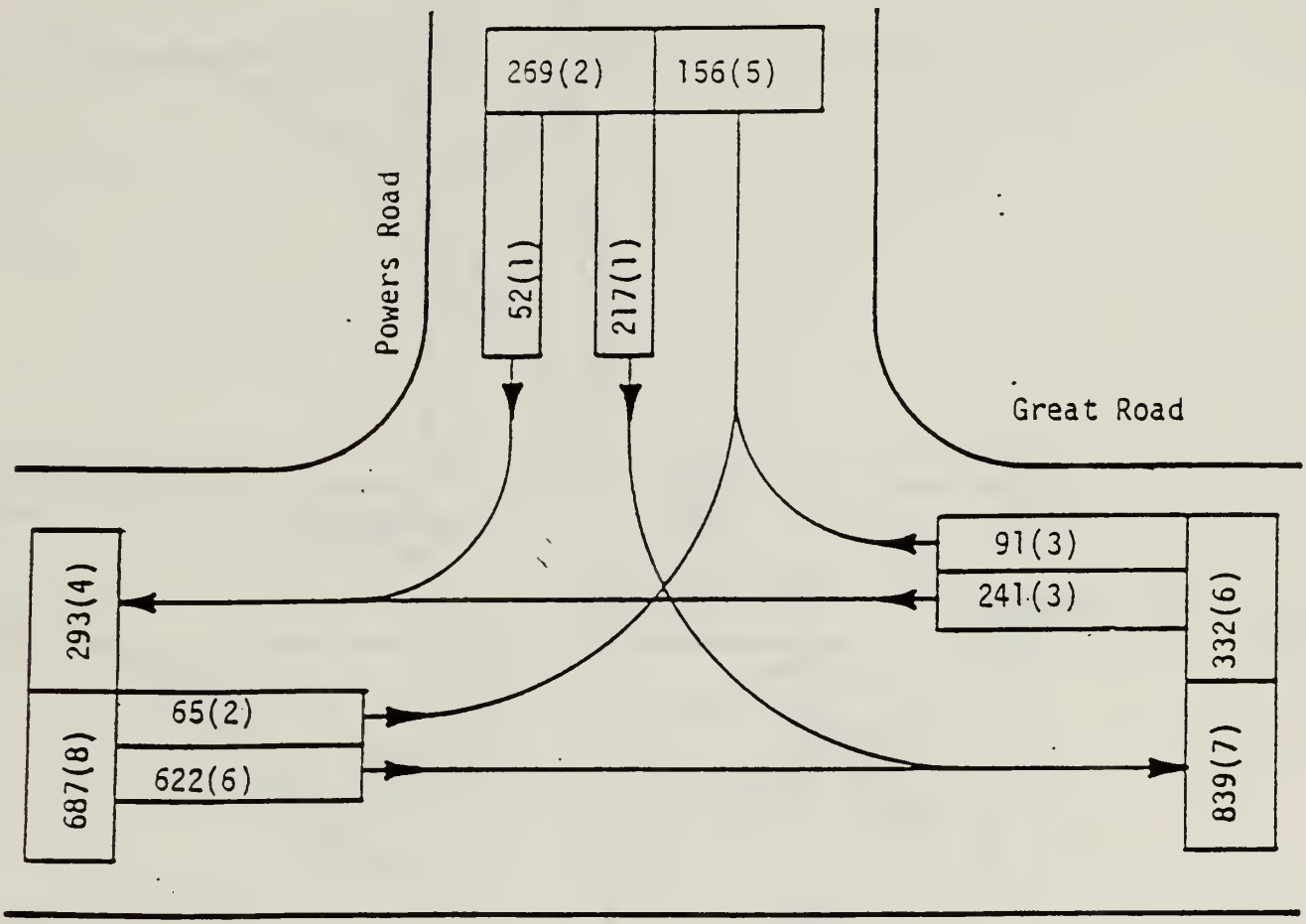
Source: ERT Field Counts

ERT

INTERSECTION TURNING MOVEMENT COUNT

CITY Littleton, MA DATE 12-2-83 DAY of WEEK Fri.

INTERSECTION Great Road/Powers Road JOB No. 0604



STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Powers Rd. (SB)	269(2)	20.9%	
Great Rd. (EB)	687(8)	53.3%	A.M. PEAK HOUR
Great Rd. (WB)	332(6)	25.8%	
			7:30-8:30 AM
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	1288(16)	100.0%	PERCENT TRUCKS

Source: Final Environmental Impact Statement for Westford Technology Park (December, 1983)

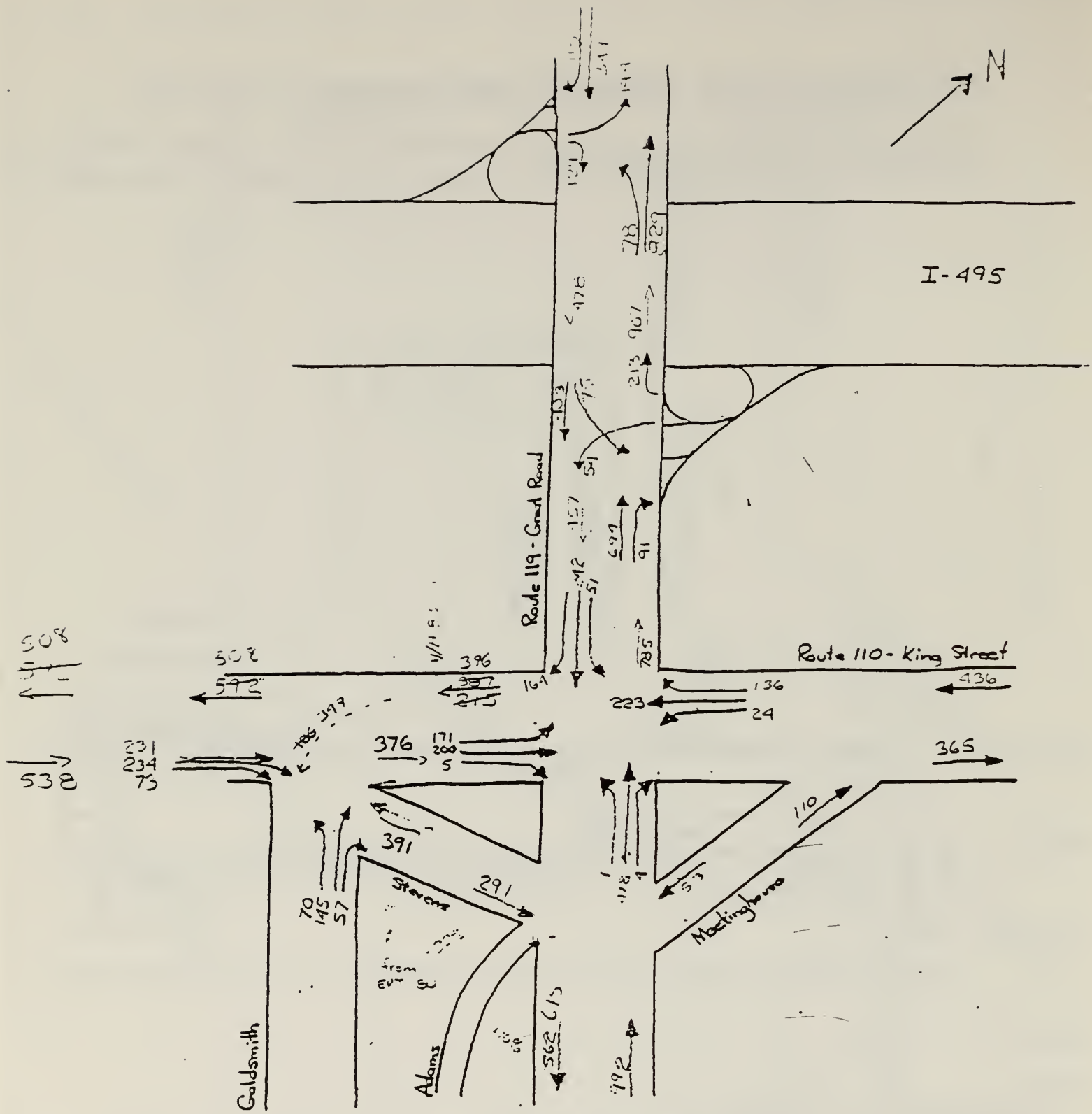
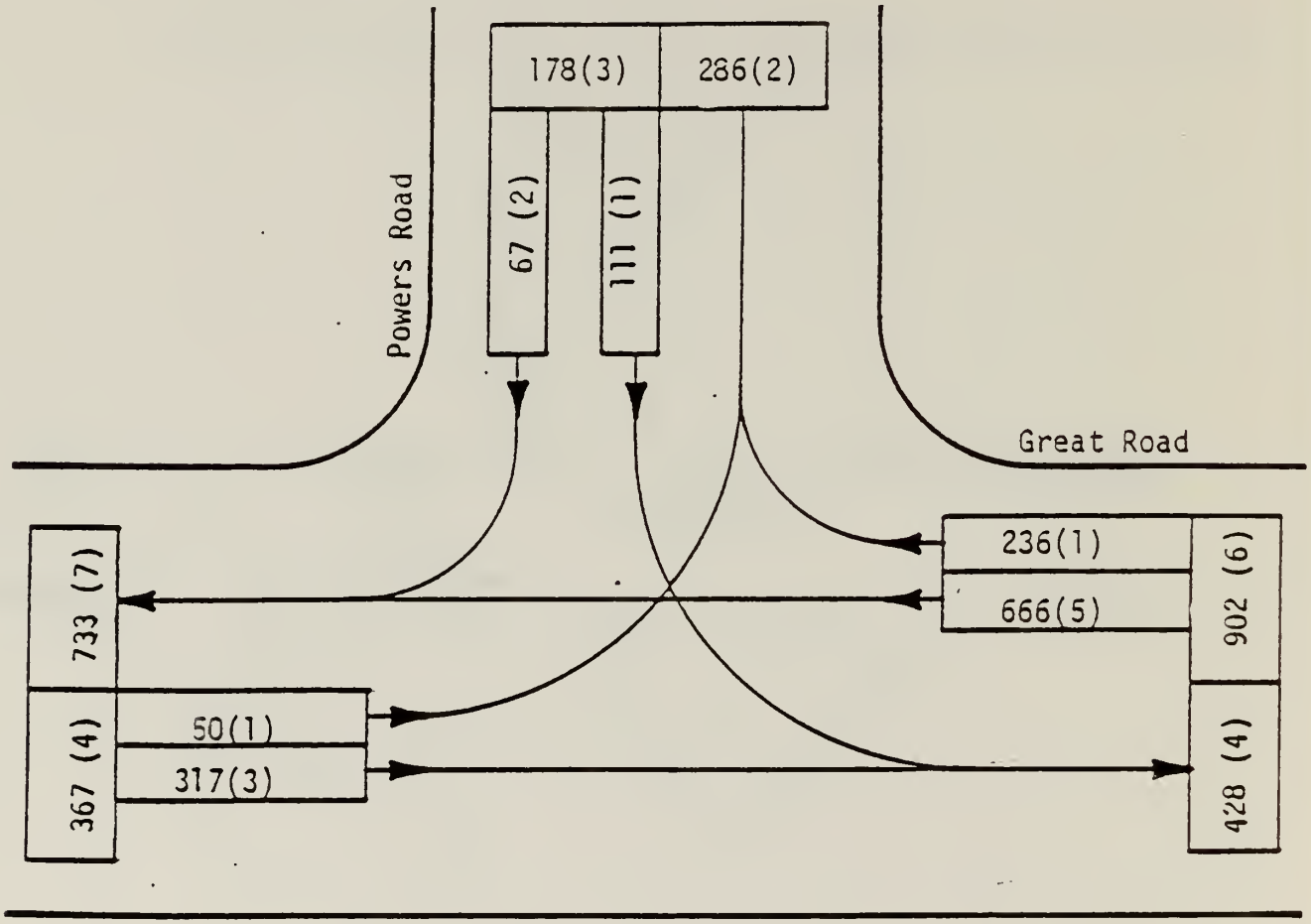


Figure M:
1984 PM Peak Hour Traffic at Littleton Common

Figure 6,
Turning Movement Counts - Route 119 @ Powers Road, PM Peak Hour, 12/1/83

INTERSECTION TURNING MOVEMENT COUNT

CITY Littleton, MA DATE 12/1/83 DAY of WEEK Thursd
INTERSECTION Great Road/Powers Road JOB No. 0604



STREET	ENTERING VOLUME	PERCENT OF FLOW	TIME of COUNT
Powers Road (SB)	178 (3)	12.3%	
Great Road (EB)	367 (4)	25.4%	P.M. Peak Hour
Great Road (WB)	902 (6)	62.3%	
			4:30-5:30 PM
			VEHICLES COUNTED
			ALL VEHICLES XXX
			TRUCKS (XX)
TOTAL	1447 (13)	100.0%	PERCENT TRUCKS

Source: Final Environmental Impact Statement for Westford Technology Park (December, 1983)